

ECOLOGICAL STUDIES AT
NAVAJO NATIONAL MONUMENT
Part I

By
Jack D. Brotherson
and
John Fairchild
Brigham Young University
Provo, Utah 84602

for
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and
Navajo National Monument

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Annual Report: Ecological Studies at Navajo National
Monument Part 1.

Introduction

This study was initiated at the request of and under contract with the National Parks Service, Southwest Region. Navajo National Monument is located in northeastern Arizona about ten miles north and west of Black Mesa and Arizona Hiway 160. The park headquarters are located on the Shonto Plateau near the head of Betatakin Canyon, a small side canyon of Tsegi canyon. The principle sites of the monument are three large Indian "cliff dwellings" of the Anasazi culture. These cliff dwellings are located in three separate canyons. Betatakin and Keet Seel Canyons are located in the Tsegi Canyon complex while Inscription House is located about twenty miles west of Betatakin in Nitsin Canyon, a branch of Navajo Canyon.

All three units lie in Pinyon-Juniper slickrock country which tends to influence heavily the environment of the monument. Within the region there exist many deep-cut canyons with high walled sandstone cliffs often reaching heights of 1000 feet above the streambeds. Within these deep canyons and along their walls, water (in the form of springs and seeps) is often encountered thus creating unique habitats in which develop plant and animal communities often foreign to the overall Pinyon-Juniper type.

Because of the historical background of the park, almost all previous studies conducted at Navajo National Monument have been archaeological in nature. Dean (1969) points out that up to that time no botanical studies of Tsegi Canyon and its environs had been completed. Apparently, he was refering to the vascular flora, since Flowers (1963) published a

study on the lichens and mosses of Betatakin Canyon and vicinity. In his introduction, Flowers (1963) briefly lists some of the dominant plant species in and around Betatakin Canyon. Woodbury (1963) at the request of the National Park Service studied the features of Betatakin Canyon and vicinity for their interpretative value and use by the park personnel. His treatment is cursory and brief.

Climate

Climatically, Navajo National Monument lies within the northeast sector of Arizona (Sellers 1964). There is a weather station at the park headquarters. Temperature and precipitation data for this station have appeared in Climatological Data, Arizona (U.S. Dept. of Commerce) since 1939.

The average annual temperature at Navajo National Monument headquarters is 50° F. The yearly maximum temperatures range from 94° to 101° F. with an average of 96.1° F. The yearly low temperatures range from -10° to +8° F. with an average of 1° F. The frost free season ranges from 107 to 213 days with an average of 155 days.

The total annual precipitation at Betatakin has historically ranged from a low of 6.84 inches to a high of 18.79 inches with an average of 11.39 inches. The period of greatest precipitation is late summer and early fall. The rainfall within the canyons is variable and spotty, with localized cloudbursts occurring more often than general rains.

Climatological data within the canyon bottoms will differ somewhat from the higher canyon rims. Temperature and relative humidity stations for two such areas at Betatakin were set out in early May, 1977 and data were collected for the months May through September. However, due to

unforseen irregularities and/or differences between the two hygrothermographs used and problems in calibration these data are as yet unavailable.

Geology

The geology of Tsegi Canyon has been treated by a number of authors (Gregory 1916 and 1917; Hack 1942 and 1945; Harshbarger, Repenning and Irwin 1957; Cooley 1958 and 1962). Navajo Sandstone is the major geological formation (Table 1) in each of the three localities. At Keet Seel and Inscription House the Navajo Sandstone is the only exposed rock formation. At Betatakin the Kayenta formation outcrops beneath the Navajo formation and can be observed in some locations in the lower reaches of the canyon. In all three canyons the Navajo Sandstone forms tall, rather sheer cliffs, up to 700 feet in height. At the base of these cliffs in each canyon tallus accumulations can be found while the canyon bottoms are filled with deep deposits of sandy alluvium (Quaternary Fill). In Keet Seel and Nitsin Canyons these alluvial deposits are deeply eroded. In Betatakin Canyon the alluvial deposits are less extensive and not nearly so thick. They are underlain by the Kayenta formation in the lower half of the canyon, and are deeply eroded, as is more characteristic of the canyon floor throughout the Tsegi Canyon system.

Plant Communities

In line with the unique geological and habitat features of Navajo National Monument, the communities within its boundaries are varied and in some cases unique. Twelve community (association) types (Table 2; Fig. 1-3) are encountered within the boundaries of the monument. Of these only one (Pinyon-Juniper mixed shrub) is found in all segments of the monument. Five of the remaining eleven community types are found in

Table 1. Major Geological Formations of Navaho National Monument.

Geological Formation	Monument Unit		
	B*	IH	KS
Kayenta Sandstone	X		
Navaho Sandstone	X	X	X
Quaternary Fill	X	X	X
Talus	X	X	X

*symbols are as follows:

B = Batatakin
 IH = Inscription House
 KS = Keet Seal

Table 2. Vegetative communities (associations) encountered within the boundaries of Navajo National Monument and the % of area and/or the acreage they occupy.

Vegetation type	Monument segment					
	Inscription House		Keet Seel		Batatakin	
	% of Area covered	Acres of Area covered	% of Area covered	Acres of Area covered	% of Area covered	Acres of Area covered
Streamside-Tree	1.8	.72				
Slickrock-Scattered						
Shrub	35.0	14.00	12.6	5.04		
Atriplex-Grass	25.9	10.36	0.2	.08		
Talus Slope	11.3	4.52	9.3	3.72		
Mixed Weed			13.5	5.40		
Pinyon-Juniper-						
Mixed Shrub	26.0	10.4	59.6	23.84	43.5	196.62
Oak			4.8	1.92	2.4	10.85
Hanging Garden			**T	T	T	T
Pinyon-Juniper-						
Sage					49.9	225.55
Pinyon-Juniper-						
Grass					3.1	14.01
Douglas Fir					0.4	1.81
Aspen					.7	3.61

* Total acreage equals:

Inscription House = 40
Keet Seel = 40
Batatakin = 452

**T = trace

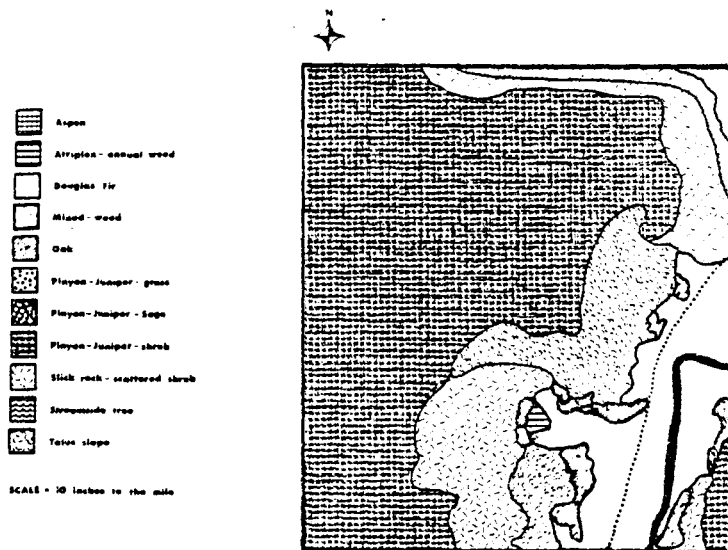


Fig. 2. Map of the plant communities (associations) of the Keet Seel segment of Navajo National Monument.

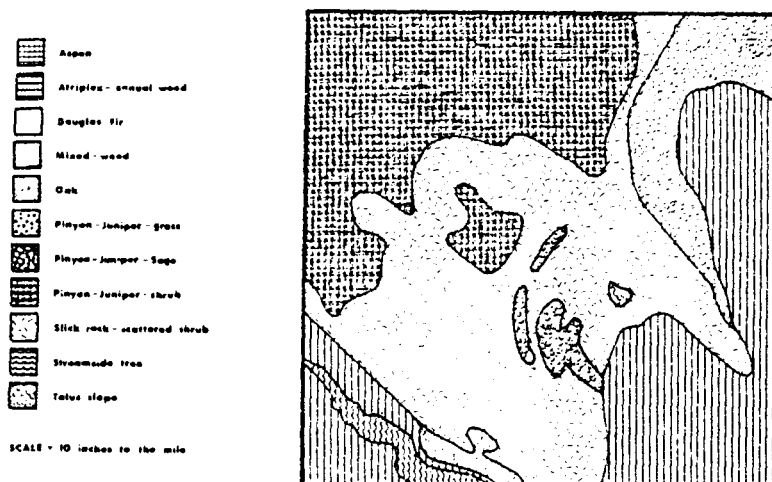


Fig. 3. Map of the plant communities (associations) of the Inscription House segment of Navajo National Monument.

two of the monument areas while six of the types are restricted to a single segment.

The community (association) types were delineated and/or described on the basis of floral distribution patterns. Distinctions were made relative to the phytogeographic patterns exhibited by dominant overstory and understory species. In some types (i.e. Oak, Aspen, etc.) distribution patterns of the dominant overstory species were enough to describe the boundaries of the type while in other cases (Pinyon-Juniper-Sage, Pinyon-Juniper-Mixed Shrub, etc.) the distribution patterns of the dominant understory species were also used. However, in cases where prominent geological features (i.e. canyon bottoms, talus, and broad areas of Slickrock, etc.) were shown to heavily influence the type, these were also taken into consideration.

Because of the uniqueness of the Betatakin Canyon area, the vegetation there is highly different and distinct when compared with adjacent Tsegi canyon and surrounding areas. Of special note is the presence in the canyon of a complex of species (i.e. Populus tremuloides, Pseudotsuga menziesii, Mahonia repens, Symphoricarpos vacinoides, etc.) more often associated with high mountain rather than desert habitat. These species are found in the canyon because of favorable moisture regimes created by the canyon geology, and Navaho sandstone hydrology.

Plant Community Type Descriptions

Type 1: Slickrock-Scattered Shrub

This type is found within the Inscription House and Keet Seel segments of the monument and represents a rather large exposed unit of Navaho sandstone. with little or no vegetation growing on it. However, growing in small isolated pockets or cracks throughout the area where

some coarsely weathered soil material has collected a few plant species can be found. Of these the shrub Cercocarpus intricatus is the most prominent.

Type 2: Streamside-Tree

This type which is found only within the Inscription House unit of the monument, represents a rather small area bordering the stream in the southwest corner of the property. It is approximately 30-50 yards wide, dominated by trees and shows a great deal of disturbance in the understory due to soil erosion and overgrazing. Important species in the type are Populus fremontii, Salix gooddingii, and Tamarix pentandra.

Type 3: Altriplex-Grass

This type is found in the two outlying segments of the monument; Inscription House and Keet Seel. In the Keet Seel unit the type occupies a rather small area at the base of the cliffs adjacent (south) to the cliff house. Here it is in fair condition not showing as much disturbance as at Inscription House. At Inscription House the type occupies almost the entire lowland area and grows almost exclusively on alluvial fill. Here it is highly disturbed from the effects of wind and water erosion and from heavy use by grazing animals. The most important species of the type are Atriplex canescens, Sporobolus airoides, Oryzopsis hymenoides, Salsola kali, and several annual weeds.

Type 4: Talus slope

This type also found in the two outlying segments of the monument occupy several disjunct areas along the base of the high walled cliffs. The underlying substratum as denoted by the type name (Talus) includes a variety of textural classes. The type occupies steep slope (50° to 80°) and exhibits a rich mixture of species in its flora. Although no one

species is highly dominant, several important to the type are Oryzopsis hymenoides, Artemisia dracunculoides, Brickellia scabra, Poa longiligula, Machaeranthera grindelioides, and Opuntia polycantha.

Type 5: Mixed-weed

This type, found only in the Keet Seel segment of the monument, represents an area in the canyon bottoms and along the stream. It is underlain by alluvial fill. The area is highly disturbed due to soil erosion and heavy grazing. The communities' use by grazing animals in the past has been severe so as to leave the vegetation devoid of perennial species. The type is presently dominated by several annual weedy species many of which are introduced exotics (i.e. Salsola kali, Chenopodium glaucum, Bromus tectorum, Cleome serrulata, Descurainia sophia, etc.).

Type 6: Pinyon-Juniper-Mixed-Shrub

This type is the most widespread plant community found within the confines of the monument. It is found to occupy sizeable areas in all three segments of the monument and is closely associated with large exposed areas of slickrock. This feature, plus an understory of several important species of shrub sets it apart from the Pinyon-Juniper-Sage and Pinyon-Juniper-Grass types. Prominent species in the type include Pinus edulis, Juniperus osteosperma, Cercocarpus intricatus, Cowania mexicana, Purshia tridentata, Fendlera rupicola, and Shepherdia rotundifolia.

Type 7: Oak

This type is found only in the segments of the monument associated with the Tsegi Canyon drainage (Keet Seel and Betatakin). In both places the type is confined to foothill areas near the base of the cliffs. As with the Talus slopes the area the type occupies are disjunct due primarily to the cloning nature of Gambel Oak (Quercus gambelii) the

dominant tree of the type. Understory in the type is composed of several grasses and forbs two of which are Poa longiligula and Lathyrus brachycalyx.

Type 8: Hanging Gardens

The Hanging Gardens as a type are highly restricted as to area occupied. They occur in the Betatakin and Keet Seel units of the monument wherein they occupy areas of rock wall surrounding springs and/or seeps. As a type they represent one of the most unique vegetative attractions in the monument. They are characterized by non-vascular (mosses, algae, and lichens) as well as vascular plants. Important vascular species in the gardens include Mimulus Eastwoodiae, Aquilegia micrantha, and Oenothera hookeri.

Type 9: Pinyon-Juniper-Sage

The Pinyon-Juniper-Sage type is located in the Betatakin unit of Navajo National Monument. As a type it lies adjacent to the Pinyon-Juniper-Mixed-Shrub type and occupies areas of alluvial fill devoid for the most part of large slickrock area. The lack of slickrock, the deep alluvial soils, and a dominance of the shrub species Artemisia tridentata in the understory distinguishes the type from the other woodland dominated types. Other species important in type are Pinus edulis, Juniperus osteosperma, along with an assortment of annual and perennial forbs and grasses.

Type 10: Pinyon-Juniper-Grass

This type also located only in the Betatakin part of the monument is found occupying the dry slopes at the foot of the high cliffs within the Canyon. The area covered is small, on fairly steep slopes (30° to 60°), and is located in the lower reaches of the canyon where there is

maximum exposure to direct rays of the sun for much of the day. The community is a woodland type dominated by Pinus edulis and Juniperus osteosperma in the overstory, but differing from types 6 and 9 in that the understory is dominated mostly by grasses (i.e. Oryzopsis hymenoides, Stipa comata, and Boutelona gracilis). Scattered plants of the shrubs Artemisia tridentata and Atriplex canescens can also be found.

Type 11: Douglas Fir

This type is restricted as a community to Betatakin canyon. However, isolated individuals of the species (Pseudotsuga menziesii) do occur within the Keet Seel segment of the monument. The community is restricted in a rather narrow band along the base of the cliffs south of the ruin. In this position the type is subjected to the direct rays of the sun only briefly each day. This northern exposure along with the seeps emanating from the Navaho Sandstone create a favorable habitat for the dominant tree species Pseudotsuga menziesii. Important species in the understory include Poa longilogula, Oryzopsis hymenoides, and Quercus gambelii.

Type 12: Aspen

The Aspen type is found only in the Betatakin Canyon area of the monument. It occurs as a long narrow community throughout most of the canyon's length where it occupies the banks of the stream found there. Its understory contains shrubs as well as other plant species generally foreign to aspen communities. This is understandable when one realizes that Aspen (not normally a part of the desert environment) is here thrown together with species representative of several major life zones. Important species in the type include Populus tremuloides, Cornus stolonifera, Betula occidentalis and Equisetum hiemale.

Not true!
stand of aspens
growing above
the canyon rim
2-2-77
1977

Flora of the Monument

The vegetation of Navajo National Monument consists of a total of 293 species of vascular plants, representing 177 genera and 66 families. Of these species 73% belong to the plant families listed in Table 3. These figures indicate the relative plant family composition of the monument. When compared with other studies (Brotherson, 1967; Campbell, 1977; and Allan, 1977) done in somewhat comparable areas of the Great Basin (Table 3) seven of the seventeen plant families listed are found to be represented in the floras of all four locations. As can be seen from the table, Arches National Park (Allan, 1977) is the most similar in its dominant family composition to that of Navajo National Monument, differing only in five of the seventeen families listed. The studies done in the Uintah Basin and Kaiparowits areas show high degrees of similarity to each other differing only in one major plant family as well as being dominated by nine of the seventeen plant families listed in the table. In light of these facts it is of interest to note that the Navajo National Monument and Arches National Park areas have as their major geological formations sandstone while the Kaiparowits and Uintah Basin study areas are underlain mainly by geological formations high in clay. The ecological and/or phytogeographical significance of the dominance of these 17 plant families and/or their relationship to the general geology of the area is not known, however, farther investigation along such lines tends to hold interest.

The species richness of the different segments of the Navajo National Monument is shown in Table 4. As can be seen, the Betatakin area exhibits more than twice as many species in its vegetation as can be found in the other areas. It also contains the greatest number of

Table 3. Dominant plant family composition of Navajo National Monument and other great basin sites.

Family	Navajo National Monument	Kaiparowits	Arches National Park	Uintah Basin
Compositae	21.2	21.4	22.0	22.0
Gramineae	12.6	15.5	13.7	9.3
Cruciferae	4.4	4.8	4.5	8.7
Leguminosae	4.4	4.8	6.9	5.8
Rosaceae	3.1		1.7	
Nyctaginaceae	3.1			
Cactaceae	3.1		1.7	
Boraginaceae	2.7	4.8	2.8	5.7
Polmoniaceae	2.7	8.3		4.0
Scrophulariaceae	2.7		2.8	5.7
Chenopodiaceae	2.4	10.7	6.6	5.8
Ranunculaceae	2.4			
Solanaceae	2.4			
Polygonaceae	2.0	4.8	3.3	5.7
Cyperaceae			1.9	
Liliaceae	2.0		1.9	
Salicaceae	2.0		1.7	
Total	73.2	75.1	71.5	72.7

Table 4. Floristic richness of the different segments of Navajo National Monument.

Area of Monument	No. of Species	No. of Species Found only at area in question
Batatakin	223	123
Keet Seal	108	16
Inscription House	108	31

species found in only one of the monument areas. This would primarily be due to two facts; (1) the much longer time the area has been protected from grazing and other man made disturbance and (2) the greater variety of habitats available in the area.

The life-form and/or growth habitat characteristics of the flora are summarized in Tables 5 and 6. Native species number 270, 92.2% of the total flora. Twenty-three species are introduced. These include such species as Tamarix pentrandia, Elaeagnus angustifolia, Chenopodium album, Salsola ali, Sisymbrium altissimum, Melilotus alba, and other species of a weedy nature. The herbaceous types of growth habit account for almost 75% of the species with shrubs and trees contributing together about 20% of the total. In area coverage however the tree and shrub dominated vegetation types (Fig. 1-3) are the most widespread types in the monument.

Checklist

The present list of plant species is the result of specimen collection at Navajo National Monument which has extended over a period of more than forty-five years. Personnel associated with the park service began collections during the late 1930's and early 1940's. Scientists from Brigham Young University began work in the monument in the summer of 1972. Since that time regular visits have been made to the area and collections have been made throughout the growing season.

Over the years the area has been visited and collections made by the following people: M. Wetherill, 1930-1938; J. W. Brewer, 1934-1947; S. P. Brewer, 1941; E. Lehnert, 1960; E. Jackson, 1961; W. S. Phillips, 1964; J. M. Rominger, 1965; M. Skougard and G. Nebeker, 1972-1973; J. Brotherson, 1972-1977; and J. Fairchild, 1977. In the list

Table 5. Plant characteristic and generalized life forms of the flora of Navajo National Monument.

Category	No. of Species in Category	Percent of Total
Total No. of Species	293	100.0
Native species	270	92.2
Introduced Species	23	7.8
Perennial Species	224	76.5
Biennial Species	21	7.2
Annual Species	48	16.4

Table 6. Growth habit characteristics of the flora of Navajo National Monument.

Category	No. of Species in Category	Percent of Total
Trees	14	4.8
Shrubs	49	16.7
Forbs	176	60.1
Grasses	37	12.6
Sedges	4	1.4
Vines	1	.3
Other	12	4.1

which follows (see below) the specimens upon which the species are based are designated and the collectors names abbreviated as follows:

MW	M. Wetherill
JWB	J. W. Brewer
SPB	S. P. Brewer
EL	E. Lehnert
EJ	E. Jackson
WSP	W. S. Phillips
JMR	J. M. Rominger
SN	M. Skougard and G. Nebeker
JF	J. Fairchild
JDB	J. D. Brotherson

Each species entry is also designated as to certain plant characteristics and according to which section of the monument it was found growing in.

These abbreviations are as follows:

P	Perennial
B	Biennial
A	Annual
N	Native
I	Introduced
T	Tree
S	Shrub
F	Forb
G	Grass
GI	Sedge
NV	Non-vascular
V	Vine
b	Betatakin
k	Keet Seel
i	Inscription House

The following list is arranged in phylogenetic order by families^{-ies} while the genera and species are arranged in alphabetical order for ease of reference. Plant identification follows the Arizona Flora (Kearney & Peebles, 1960), Seed Plants of Northern Arizona (McDougal, 1973), Manual of the Plants of Colorado (Harrington, 1964) and Utah Plants (Welsh and Moore, 1975).

TAXA

Plant Characteristics

Subdivision Lycopsidea

Selaginellaceae - Selaginella family

Selaginella mutica D. C. Eaton. (WSP 3617, PNNVb
19 June 1964)

Subdivision Sphenopsida

Equisetaceae - Horsetail family

Equisetum hiemale L. (WSP, 19 June 1964) PNFB
Western scouringrush

Subdivision Pteropsida

Class Gymnospermae

Pinaceae - Pine family

Pinus edulis Engelm. (SN 94; JMR 389- PNTbik
65, 22 August 1965)
Pinyon pine

Pseudotsuga menziesii (Mirb.) Franc. PNTbk
(SN)
Douglas-fir

Cupressaceae - Cypress family

Juniperus osteosperma (Torr.) Little PNTbik
(SN 156; JF 5, 25 July 1977)
Utah juniper

Ephedraceae - Joint-fir family

Ephedra viridis Covill. (SN 125; PNSbik
JF 256, 17 May 1977)
Green Mormon tea

Class Angiospermae

Subclass Monocotyledoneae

Sparganiaceae - Bur-reed family

Sparganium eurycarpum Engelm. PNGLi
(JF 226, 26 June 1977)
Giant burreed

Juncaginaceae - Arrowgrass family

Triglochin maritima L. (JF 227, PNGLi
26 June 1977)
Arrowgrass

Gramineae - Grass family

- Agropyron caninum (L.) Beauv. PNGbk
(SN 85, 10 June 1972; JF 182,
3 June 1977)
Slender wheatgrass
- Agrostis exarata Trin. (SN 182, PNGi
2 July 1972)
Spike redtop
- Agrostis semiverticillata PIGk
(Forsk.) C. Chr. (SN 356, 24
July 1973; JF 38, 27 July 1977;
JF 118, 25 June 1977)
Water bentgrass
- Alopecurus aequalis Sobol. (SN PNGk
354, 24 July 1973)
Shortawn foxtail
- Andropogon hallii Hack. (JF PNGi
66, 1 September 1977)
Sand bluestem
- Aristida arizonica Vasey (SN 188, PNGb
2 July 1973)
Arizona threeawn
- Aristida fendleriana Steud. (JF PNGbi
100, 25 June 1977; JF 117,
25 June 1977)
Fendler threeawn
- Bouteloua barbata Lag. (JF 72, ANGi
1 September 1977)
Sixweeks grama
- Bouteloua curtipendula (Michx.) PNGi
Torr. (SN 347, 29 June 1973)
Sideoats grama
- Bouteloua gracilis (H.B.K.) Lag. PNGb
(JF 284, 30 June 1977)
Blue grama
- Bromus carinatus Hook. & Arn. (SN PNGbk
224, 3 July 1972)
Mountain brome
- Bromus ciliatus L. (SN 84, PNGb
10 June 1972; JF 181, 3 June
1977)
Fringed brome

- Bromus marginatus Nees. (JF 168, PNGb
30 June 1977)
Big mountain brome
- Bromus rubens L. (JF 104, 25 AIGik
June 1977)
Foxtail chess
- Bromus tectorum L. (SN 207, 3 July AIGbik
1973; JF 192, 3 June 1977)
Cheat grass
- Elymus glaucus Buckl. (JF 42, PNGb
18 July 1977)
Blue wildrye
- Festuca octoflora Walt. (SN; JF ANGbik
269, 18 May 1977)
Sixweeks fescue
- Glyceria striata (Lam.) Hitch. (JF PNGb
7, 25 July 1977)
Fowl mannagrass
- Hordeum leporinum Link. (SN) ANGb
Rabbit barley
- Lycurus phleoides H.K.B. (JF 23, PNGi
20 July 1977)
Wolftail
- Muhlenbergia andina (Nutt.) PNGb
Hitch. (JF 8, 1 September 1977)
Foxtail muhly
- Muhlenburgia curtifolia Scribn. PNGi
(JMR 352-65, 21 August 1965)
Utah muhly
- Muhlenbergia pungens Thurb. (JMR PNGb
342-65, 21 August 1965; SN 243,
27 July 1972)
Sandhill muhly
- Muhlenbergia thurberi Rydb. (JF PNGbi
120, 25 June 1977)
Thurber muhly
- Munroa squarrosa (Nutt.) Torr. ANGi
(SN; JF 9, 30 August 1977; JF
61, 1 September 1977)
False buffalograss

- Oryzopsis hymenoides (R. & S.) PNGbik
Riker. (SN 343, 29 June 1973)
Indian ricegrass
- Oryzopsis micrantha (Trin. & Rupr.) Thurb. (SN 86, 10 June 1972; JF 179, 3 June 1977) PNGb
Littleseed ricegrass
- Poa fendleriana Vasey (MW 7; MW 28; SN 275, 17 May 1973) PNGbk
Muttongrass
- Poa longiligula Scribn. & Williams. (SN; MW 14; JF 94, 13 June 1977; JF 99, 25 June 1977) PNGbik
Longtongue muttongrass
- Poa pratensis L. (SN 357, 24 July 1973; JF 167, 30 June 1977) PIGbk
Kentucky bluegrass
- Polypogon monspeliensis (L.) Desf. (SN 351, 24 July 1973; JF 110, 25 June 1977) AIGbik
Rabbitfoot grass
- Puccinellia airoides (Nutt.) Wats. & Coult. (JF 170, 30 June 1977) PNGbk
Nuttal alkaligrass
- Sitanion hystrix (Nutt.) J. G. Smith. (SN 323, 19 June 1973; JF 82, 13 June 1977) PNGbik
Bottlebrush squirreltail
- Sporobolus airoides (Torr.) Torr. (JF 22, 19 July 1977) PNGik
Alkali sacaton
- Sporobolus cryptandrus (Torr.) Gray (JMR 344-65, 21 August 1965; SN 228, 3 July 1972; JF 96, 25 June 1977) PNGbik
Sand dropseed
- Sporobolus flexuosus (Thurb.) Rydb. (SN) PNGb
Mesa dropseed
- Stipa comata Trin. & Rupr. (SN 80; JF 180, 3 June 1977) PNGbk
Needle and thread

Cyperaceae - Sedge family

- Carex occidentalis Bailey (JF 51, 12 July 1977; JF 173, 16 June 1977)
Western sedge PNGb
- Carex rossii Boott. (JF 172, 16 June 1977)
Ross sedge PNG1b
- Eleocharis macrostachya Britton (JF 28, 1 September 1977; JF 119, 25 June 1977)
Spike rush PNGLbi

Commelinaceae - Spiderwort family

- Tradescantia occidentalis (Britt.) Smyth. (SN 151; JF 80, 16 June 1977; JWB NB 22, 12 June 1939; JMR 335-65, 22 August 1965)
Prairie spiderwort PNFbik

Juncaceae - Rush family

- Juncus balticus Willd. (JF 171, 16 June 1977)
Baltic rush PNGLbi

Liliaceae - Lily family

- Allium macropetalum Rydb. (JWB NB 11, 20 May 1939; SN 326, 20 June 1973)
Large flowered onion PNFb
- Calochortus Nuttallii Torr. & Gray (SN 99, 10 June 1972; JWB NB 13, 10 June 1939)
Sego lily PNFb
- Fritillaria atropurpurea Nutt. (SN 287, 23 May 1973, MW 287, May 1930)
Purple spot fritillary PNFb
- Smilacina stellata (L.) Desf. (MW Y-4; SN 148, 3 July 1972; SN 223, 3 July 1972; JF 154, 30 June 1977)
Starry falsesolomonseal PNFbk

Yucca angustissima Engelm. (SN 56, 9 June 1972; JWB NB 76, 21 June 1941) PNSbik
Fineleaf yucca

Yucca baccata Torr. (SN 315, 19 June 1973) PNSb
Datil yucca

Orchidaceae - Orchid family

Habenaria sparsiflora S. Wats. (SN 167, 1 July 1972) PNFb
Canyon habeneria

Subclass Dicotyledonae

Salicaceae - Willow family

Populus angustifolia James. (JF 281, 30 June 1977) PNTi
Narrowleaf cottonwood

Populus Fremontii S. Wats. (SN 179) PNTbi
Fremont cottonwood

Populus tremuloides Michx. (SN 171) PNTb
Quaking aspen

Salix exigua Nutt. (SN 181, 2 July 1972) PNSbi
Sandbar willow

Salix Gooddingii Ball (SN; JF 128, 25 June 1977) PNSbk
Goodding willow

Salix lasiolepis Benth. (JF 208, 21 May 1977) PNTb
Arroyo willow

Betulaceae - Birch family

Betula occidentalis Hook. (SN 145, 1 July 1972; MW 457; WSP 5615, 19 June 1964; JWB NB 33, 17 July 1940) PNTb
Water birch

Fagaceae - Beech family

Quercus gambelii Nutt. (SN 160, PNTbk
1 July 1972; JF 214, 21 May 1977;
JWB NB 40, 17 July 1940)
Gambel oak

Quercus turbinella Greene (JF 27, PNSi
1 September 1977)
Live oak

Urticaceae - Nettle family

Parietaria pensylvanica Muhl. ANFi
(JF 123, 25 June 1977)
Pennsylvania pellitory

Loranthaceae - Mistletoe family

Arceuthobium campylopodum Engelm. PNFb
(MW AB-1, 23 August 1937)
Western dwarfmistletoe

Phoradendron juniperinum Engelm. PNFb
(SN 198)
Juniper mistletoe

Santalaceae - Sandalwood family

Commandra pallida DC. (JF 149, PNFbk
30 June 1977; JF 196, 31 May
1977)
Bastard toadflax

Polygonaceae - Buckwheat family

Eriogonum alatum Torr. ex Sitgr. PNFb
(SN 197, 3 July 1972; JF 46,
7 July 1977)
Winged eriogonum

Eriogonum cernuum Nutt. (SN ANFb
235, 20 July 1972)
Nodding eriogonum

Eriogonum cognatum Greene (JF PNFb
280, 1 September 1977)
Sulphurflower eriogonum

Eriogonum corymbosum Benth. in PNSi
DC (JF 281, 1 September)
Corymbed eriogonum

Eriogonum microthecum Nutt. (EJ, PNSb
16 August 1961; JMR 338-65, 21
August 1965; SN 239, 24 July 1972;
JF 244, 8 May 1977)
Slenderbush eriogonum

Erigonum umbellatum Torr. (JWB NB PNSi
35, 17 July 1940; JMR 334-65,
21 August 1965; JF 32, 1 September
1977)
Sulfer eriogonum

Chenopodiaceae - Goosefoot family

Atriplex canescens (Pursh) Nutt. PNSbik
(MW 419, 27 June 1935; JF 203,
21 May 1977)
Fourwing saltbush

Chenopodium album L. (JF 278, 13 AIFbik
August 1977)
Lambsquarter

Chenopodium fremontii Wats. (MW ANFbik
K-1; JF 242, 30 June 1977)
Fremont goosefoot

Chenopodium glaucum (SN 204, AIFik
3 July 1972; JF 136, 30 June 1977)
Oakleaf goosefoot

Chenopodium pratericola Rydb. (JF ANFik
160, 30 June 1977)
Slimleaf goosefoot

Kochia scoparia (L.) Schrad. (JF AIFi
115, 26 June 1977)
Belvedere summercyprus

Salsola Kali L. (SN) AIFbik
Russian thistle

Amaranthaceae - Amaranth family

Amaranthus albus L. (JF 130, ANFi
25 June 1977)
Tumble pigweed

Amaranthus leucocarpus Wat. (JF AIFk
18, 28 August 1977)
Love-lies-bleeding

Nyctaginaceae - Four o'clock family

Abronia elliptica A. Nels. (JWB NB 51, 27 May 1941; JF 187, 3 June 1977) PNFbik
Redstem sandverbena

Abronia fragrans Nutt. ex Hook. (SN) PNFb
Snowball sandverbena

Allionia incarnata L. (JF 65, 1 September 1977) PNFi
Trailing allionia

Allionia linearis Pursh (JWB NB 20, 12 June 1939) PNFb
Thinleaf allionia

Mirabilis multiflora (Torr.) Gray (SN 174, 2 July 1972; JF 21, 20 July 1977; JF 112, 25 June 1977) PNFi
Colorado four o'clock

Mirabilis oxybaphoides Gray (JF 34, 27 July 1977) PNFk
Three flowered four o'clock

Oxybaphus comatus (Small) (SN 361, 24 July 1973) PNFk
Weatherby. Common umbrellawort

Oxybaphus linearis (Pursh) Robins. (JWB NB 20) PNFb
Thinleaf umbrellawort

Tripterocalyx wootonii Standl. (JMR 385-65, 22 August 1965; JWB NB 67, 19 May 1941; JF 31, 1 September 1977) ANFbi
Skyrocket four o'clock

Portulacaceae - Portulaca family

Portulaca oleraceae L. (JF 14, 30 August 1977; JF 69, 20 July 1977) AIFi
Common purslane

Portulaca retusa Engelm. (JF 73, 27 July 1977) AIFk
Blunt purslane

Talinum brevifolium Torr. (SN PNF*i*
173, 2 July 1972; JF 16, 30 August
1977)
Small-leaf fameflower

Caryophyllaceae - Pink family

Arenaria eastwoodiae Rydb. (JF PNF*bik*
145, 30 June 1977)
Eastwood sandwort

Ranunculaceae - Crowfoot family

Aquilegia micrantha Eastw. (JWB PNF*b*
NAV-B-101-47, 17 June 1947; JWB
NB 31, 14 July 1940; SN 93, 10
June 1972)
Columbine

Clematis ligusticifolia Nutt. (SN PNF*b*
229, 3 July 1972)
Western Virgins bower

Delphinium amabile Tidestr. (SN) PNF*b*

Delphinium nelsonii Greene (JWB PNF*b*
1080-1704, 27 May 1941; JWB NB
6, 11 May 1939; SN 302, 1 June
1973)
Nelson larkspur

Delphinium scaposum Greene (JWB PNF*b*
AM-4, 17 June 1941)
Tall Mountain larkspur

Ranunculus cymbalaria Pursh (JF PNF*i*
111, 25 June 1977; JF 125, 25
June 1977; MW AM-5)
Alkali buttercup

Thalictrum fendleri Engelm. (JWB PNF*b*
NB 44, 2 September 1940; JWB NAV-B
-101-47, 17 June 1947)
Fendler meadowrue

Berberidaceae - Barberry family

Mahonia repens G. Don. (SN 269, PNS*bk*
17 May 1973; MW 459, 21 May
1935; EL, 17 April 1960; JWB E 1,
9 May 1941)
Oregon grape

Papaveraceae - Poppy family

Corydalis aurea Willd. (SN ANFb
201, 3 July 1972)
Golden corydalis

Cruciferae - Mustard family

Arabis perennans S. Wats. (JWB PNFbi
NB 46, 19 April 1941; JF 220, 5
May 1977)
Rockcress

Arabis pulchra Jones (EL, 17 PNFb
April 1960)
Beauty rockcress

Descurainia pinnata (Walt.) ANFbk
Britton (JWB P-4, 23 June 1941;
JF 156, 30 June 1977)
Pinnate tansymustard

Descurainia sophia (L.) Webb. AIFbik
(EL, 17 April 1960; SN 73, 9 June
1972)
Flixweed tansymustard

Erysimum asperum DC. (JWB NB 52, PNFbk
30 May 1941; JWB NB 7, 11 April
1939; SN 286, 21 May 1973; JF
225, 5 May 1977)
Wallflower

Lepidium montanum Nutt. (SN 195, PNFbik
3 July 1972; JF 63, 1 September
1977)
Montana pepperwood

Lesquerella ludoviciana (Nutt.) S. PNFb
Wats. (JWB NB 8, 20 May 1936; SN
303, 1 June 1973)
Foothill bladderpod

Lesquerella rectipes Woot. & PNFb
Standl. (JF 184, 3 June 1977)
Straight bladderpod

Sisymbrium altissimum L. (JR AIFbk
389-65, 22 August 1965; JF
158, 30 June 1977)
Tumble mustard

Streptanthella longirostris (S. ANFbik
Wats.) Rydb. (SN)
Longbeak streptanthella

Streptanthus cordatus Nutt. ex PNFb
Torr. & Gray (SN 75, 9 June
1972; JWB NB 34, 17 July 1940;
JWB NB 59, 20 April 1941; EL, 17
April 1960; JF 135, 30 June 1977)
Heartleaf twistflower

Thelipodium integrifolium (Nutt.) BNFk
Endl. (JF 2, 24 July 1977)
Entire leaved thelypody

Thlaspi fendleri Gray (SN; JWB PNFb
NB 47, 19 April 1941)
Blue pennycress

Capparidaceae - Caper family

Cleome serrulata Pursh (JWB NB 21, ANFbik
16 June 1939, MW I-1, 8 August
1937; JF 109, 25 June 1977)
Rocky mountain bee plant

Crassulaceae - Orpine family

Sedum stenopetalum Pursh (JWB PNFb
NB 54, 28 May 1941)
Wormleaf stonecrop

Saxifragaceae - Saxifrage family

Fendlera rupicola Gray (SN 289, PNSbk
24 May 1973; JF 212, 21 May
1977)
Cliff fendlerbush

Heuchera parvifolia Nutt. (SN 118, PNFb
10 June 1972)
Littleleaf alumroot

Heuchera rubescens Torr. (SN 311, PNFb
19 June 1973)
Red alumroot

Ribes cereum Dougl. (JF 142, 30 PNSbk
June 1977; JF 204, 21 May 1977)
Wax currant

Ribes leptanthum Gray (JF 169, 30 June 1977; JF 205, 21 May 1977) PNSk
Trumpet gooseberry

Ribes viscosissimum Pursh (SN 290, 24 May 1973) PNSk
Sticky currant

Rosaceae - Rose family

Amelanchier utahensis Koehne. PNSb
(SN 129, 10 June 1972; JF 213, 21 May 1977; SPB NB 62, 18 June 1941)
Utah service berry

Cercocarpus intricatus S. Wats. PNSbik
(SN 261, 17 May 1973; JWB NB 63, 12 May 1941; MW 452; JF 218, 5 May 1977)
Littleleaf mt. mahogany

Cowania mexicana D. Don. (SN 65) PNSb
Cliffrose

Fallugia paradoxa (D. Don.) Endl. PNSi
(JF 64, 1 September 1977)
Apache plume

Holodiscus dumosus (Nutt.) PNSb
Heller. (MW 919-3044; JWB 1080-1709, June 1942; MW 434)
Bush rockspirea

Prunus emarginata (Dougl.) PNTk
Walp. (SN 288, 24 May 1973; JF 163, 30 June 1977)
Bitter cherry

Prunus virginiana L. (SN 309, 2 June 1973) PNTb
Chokecherry

Purshia tridentata (Pursh) DC. PNSbk
(SN 307, 1 June 1973)
Antelope bitterbrush

Rosa woodsii Lindl. (SN 113, 10 June 1972; JWB NB 16, 7 June 1939; JF 157, 30 June 1977) PNSb
Woods rose

Leguminosae - Pea family

- Astragalus amphioxys Gray (SN) PNFb
Crescent milkvetch
- Astragalus ceramicus Sheld. (SN PNFb
103, 10 June 1972; JWB NB 10,
11 May 1939; JF 81, 16 June
1977)
Painted milkvetch
- Astragalus lentiginosus Dougl. ex PNFbik
Hook. (SN 251, 8 May 1973; JF 70,
20 July 1977; JF 132 25 June 1977)
Specklepod locoweed
- Astragalus mollissimus Torr. (SN PNFb
101, 10 June 1972; JF 84, 13 June
1977)
Woolly locoweed
- Astragalus sesquiflorus S. Wats. PNFb
(EL, 17 April 1960; SN 276, 17
May 1973)
Sandstone milkvetch
- Astragalus Thompsonae S. Wats. PNFb
(EL, 17 April 1960)
Thompson milkvetch
- Astragalus zionis Jones (JF 317, PNFbik
27 July 1977; JF 178, 5 May 1977)
Zion milkvetch
- Lathyrus arizonicus Britton PNFb
(JF 261, 17 May 1977)
Arizona pea vine
- Lathyrus brachycalyx Rydb. (SN PNFb
111, 10 May 1972; JF 211, 21 May
1977; JWB X-3, 11 May 1941)
Shortcalyx peavine
- Lupinus argenteus Pursh (JF 35, PNFb
27 July 1977)
Silvery lupine
- Medicago sativa L. (SN 105, 10 PIFb
June 1972)
Alfalfa

Melilotus alba Desr. (JF 57, 22 July 1977) BIFb
White sweetclover

Melilotus officinalis (L.) Lam. BIFb
(JF 58, 22 July 1977)
Yellow sweetclover

Geraniaceae - Geranium family

Erodium cicutarium (L.) L'Her. AIFbik
(SN 252, 8 May 1973)
Cutleaf filaree

Geranium atropurpureum Heller. PNFb
(SN 116, 10 June 1972; JWB NB 28, 25 July 1940; JWB NB 42, 17 July 1940; JF 75, 12 July 1977)
Pineywoods geranium

Linaceae - Flax family

Linum aristatum Engelm. ex ANFi
Wisliz. (MW Z-1, 13 August 1937; SN; JF 30, 1 September 1977)
Bristle flax

Linum perenne L. (MW 65, 27 May 1935) PNFb
Blue flax

Euphorbiaceae - Spurge family

Euphorbia lurida Engelm. (JWB NB 56, 28 May 1941) PNFb
Shining spurge

Euphorbia micromera Boiss. (JF 26, 19 July 1977) ANFi
Littleleaf spurge

Anacardaceae - Cashew family

Rhus trilobata Nutt. (SN 227, 3 July 1972) PNSbik
Squawbush

Toxicodendron radicans (L.) O. Ktze. (MW 413) PNSb
Poison ivy

Aceraceae - Maple family

Acer negundo L. (JWB NB 17, PNTbk
7 June 1934; SN 264, 17 May 1973)
Boxelder

Malvaceae - Mallow family

Sidalcea neomexicana Gray. (SN) PNFb
New Mexico checkermallow

Sphaeralcea coccinea (Pursh) Rydb. PNFbik
(SN 335, 29 June 1973; JF 71, 20
July 1977; JF 85, 13 June 1977)
Scarlet globemallow

Sphaeralcea parvifolia A. Nels. PNFbik
(JWB NB 72, 19 June 1941; SN 68,
2 June 1972; JF 248, 16 May 1977)
Small-leaf globemallow

Tamaricaceae - Tamarix family

Tamarix pentandra Pall. (JF 283, PISi
30 June 1977)
Saltcedar

Loasaceae - Loasa family

Mentzelia albicaulis Dougl. (JWB ANFb
NB 5, 11 May 1939; SN 338,
29 June 1973)
Whitestem blazingstar

Cactaceae - Cactus family

Corypantha vivipara (Nutt.) PNSk
Britton & Rose (JF 90, 10 June
1977)

Echinocereus fendleri (Engelm.) PNSbik
Rumpler. (JWB NB 74, 17 June 1941)
Hedgehog cactus

Echinocereus triglochidiatus PNSb
Engelm. (SN 325, 19 June 1973)
Strawberry hedgehog cactus

Opuntia erinacea Engelm. & Bigel. PNSbik
(JWB NB 78, 21 June 1941)
Grizzlybear pricklypear

Opuntia fragilis (Nutt.) Haw. (JWB PNSb
H-4, 19 June 1941)
Brittle pricklypear

Opuntia polycantha Haw. (SN 331, PNSbik
20 June 1973; JF 91, 10 July
1977)
Plains pricklypear

Opuntia whipplei; Engelm. & Bigel. PNSi
(JF 277, 30 June 1977)
Whipple cholla

Sclerocactus whipplei (Engelm. & Bigel.) Britt. & Rose. (JWB NB 75,
19 June 1941; SN) PNSbk

Sclerocactus parviflorus Clover & Jotter (SN) PNSb

Elaeagnaceae - Oleaster family

Elaeagnus angustifolia L. (JF 106, PITi
25 June 1977)
Russian olive

Shepherdia rotundifolia Parry (SN 281, 17 May 1973; JF 217,
5 May 1977) PNSbik
Roundleaf buffaloberry

Onagraceae - Evening primrose family

Epilobium hornemannii Reichenb. (JF 74, 24 July 1977) PNFk
Hornemann willowweed

Oenothera albicaulis Pursh (SN 106, 10 June 1972) ANFbi
Prairie evening primrose

Oenothera caespitosa Nutt. (SN 194; JF 92, 10 June 1977) PNFbik
Tufted evening primrose

Oenothera hookeri Torr. & Gray. (JWB, 1941) BNFB
Hooker evening primrose

Oenothera longissima Rydb. (JF 43, 12 July 1977) BNFB
Longnose evening primrose

Oenothera pallida Lindl. (JR PNF*i*
398-65, 22 August 1965; SN 217,
3 July 1972; JF 207, 21 May
1977)
Pale evening primrose

Umbelliferae - Parsley family

Cymopterus Newberryi (S. Wats.) PNF*b*
M. E. Jones (JWB, 16 May 1941)
Newberry spring parsley

Cornaceae - Dogwood family

Cornus stolonifera Michx. (JWB PNS*b*
NB 39, August 1940; MW 41,
May 1935; SN 308, 2 June
1973)
Redosier dogwood

Ericaceae - Heather family

Arctostaphylos pungens H. B. K. PNS*b*
(MW 109)
Pointleaf manzanita

Primulaceae - Primrose family

Androsace septentrionalis L. (JF ANF*b*
47, 14 July 1977)
Pigmyflower rockjasmine

Oleaceae - Olive family

Fraxinus anomala Torr. (MW 297) PNT*i*
Singleleaf ash

Apocynaceae - Dogbane family

Apocynum medium Greene (MW 431, PNF*b*
10 June 1955)
Intermediante dogbane

Asclepiadaceae - Milkweed family

Asclepias subverticillata (Gray) PNF*i*
Vail. (SN 175, 2 July 1972; JF
62, 1 September 1977)
Western-whorled milkweed

Funastrum heterophyllum (Englem.) PNF*k*
Standle. (MW 221; JF 19, 28 August
1977)
Common climbing milkweed

Cryptantha flava (A. Nels.) Payson PNFbk
(SN 74, 9 June 1972; JF 93, 11
June 1977)
Yellow cryptantha

Cryptantha jamesii (Torr.) Payson PNFbi
(SN 152, 1 July 1972; JF 15, 30
August 1977); JF 50, 22 July 1977)
James cryptantha

Cryptantha pterocarya (Torr.) ANFb
Greene (SN, 3 July 1972)

Lappula occidentalis (Wats.) AIFb
Greene (JF 222, 5 May 1977)
Western stickseed

Lappula redowskii (Hornem.) AIFb
Greene (SN 70, 9 June 1972; JF
189, 3 June 1977; MW G-2, 15 May
1937)
Stickseed

Lithospermum multiflorum Torr. PNFb
(JF 40, 14 July 1977)
Manyflower gromwell

Verbenaceae - Vervain family

Verbena bracteata Lag. & Rodr. PNFb
(SN 337, 29 June 1973)
Bigbracht verbena

Labiata - Mint family

Moldovica parviflora (Nutt.) BNFb
Britt. & Brown (SN 218, 3 July
1973)

Solanaceae - Potato family

Chamaesarcha coronopus (Dunal) PNFb
Gray (SN 183, 2 July 1972)
Crown chamaesaracha

Datura meteloides DC. (JF 282, ANFbik
30 June 1977)
Sacred datura

Lycium pallidum Miers. (SN; JF PNSi
98, 26 June 1977)
Pale wolfberry

- Nicotiana attenuata Torr. (JMR 400-65, 22 August 1975) PNFi
Coyote tobacco
- Physalis fendleri Gray (SN 158, 1 July 1972; JF 137, 30 June 1977) PNFbi
Fendler groundcherry
- Physalis hederifolia Gray (JF 153, 30 June 1977) PNFk
Ivyleaf groundcherry
- Solanum Jamesii Torr. (JF 17, 28 August 1977) PNFk
James nightshade

Scrophulariaceae - Figwort family

- Castilleja linariaefolia Benth. PNFbik
(SN 96, 10 June 1972; JF 49, 22 July 1977; JF 134, 30 June 1977)
Wyoming painted cup
- Cordylanthus Wrightii Gray (JMR 340-65, 21 August 1965; EJ, 16 August 1961) ANFb
Wright birdbeak
- Mimulus Eastwoodiae Rydb. (SN 221; JF 20, 20 July 1977; JF 165, 30 June 1977) PNFbk
Creeping scarlet monkey flower
- Penstemon ambiguus Torr. (EL; SN; JF 230, 18 May 1977) PNSb
Gilia penstemon
- Penstemon barbatus (Cav.) Roth PNFb
(JF 59, 22 July 1977)
Beardlip penstemon
- Penstemon comarrhenus Gray (JWB 27 June 1947; JF 162, 30 June 1977) PNFb
Dusty penstemon
- Penstemon Eatoni Gray (SN 108, 10 June 1972; JDB 2503, 3 August 1974) PNFb
Eaton penstemon

Penstemon virgatus Gray (JF 52, PNFb
12 July 1977)
Wandbloom penstemon

Plantaginaceae - Plantain family

Plantago purshii Roem. & Schult. PNFb
(SN 333, 27 June 1973)
Indian wheat

Rubiaceae - Madder family

Galium aparine L. (JF 166, 30 ANFk
June 1977)
Catchweed bedstraw

Galium triflorum Michx. (SN 154, PNFb
1 July 1972)
Sweetscented bedstraw

Kelloggia galioides Torr. (JF PNFbk
241, 3 June 1977)
Milk kelloggia

Caprifoliaceae - Honeysuckle family

Symphoricarpos vaccinioides Rydb. PNSb
(SN 310, 2 June 1973)
Snowberry

Compositae - Sunflower family

Achillea millefolium L. (SN PNFbk
349, 24 July 1973)
Common yarrow

Ambrosia artemisiifolia L. (JF ANFik
126, 25 June 1977)
Common ragweed

Antennaria aprica Greene (JWB NB PNFb
58, 28 May 1941; MW, 10 June 1937)

Antennaria marginata Greene (JF PNFb
39, 14 July 1977)

Antennaria neglecta Greene (SN PNFb
150, 1 July 1972)
Field pussytoes

Antennaria parvifolia Nutt. (SN PNFb
120; JWB NB 58)
Small-leaf pussytoes

- Artemisia campestris L. (JF 239, PNFb
16 June 1977)
Sagewort wormwood
- Artemisia dracunculoides Pursh PNFbik
(JWB NB 37, 17 July 1940; JF 103,
25 June 1977)
Tarragen
- Artemisia frigida Willd. (SN 359, PNSbik
24 July 1973; JF 202, 21 May 1977;
MW 451)
Fringed sagewort
- Artemisia ludoviciana Nutt. (JF PNFbik
87, 15 July 1977; JF 107, 25
June 1977)
Louisiana sagewort
- Artemisia nova A. Nels. (JF 279, PNSbk
25 August 1977)
Black sage
- Artemisia pacifica Nutt. (JF 3, PNFb
16 August 1977)
- Artemisia tridentata Nutt. (MW PNSbk
451; SN 360, 24 July 1973)
Big sagebrush
- Aster arenosus (Heller) Blake (JF PNFb
233, 30 June 1977)
- Aster hirtifolius Blake. (SPB PNFb
M-5, 23 June 1941; SN 316, 19
June 1973)
- Aster linearis (Greene) Gray (JMR PNFbk
343-63, 21 August 1965)
- Brickellia californica (Torr. & PNSbik
Gray) Gray (JF 129, 25 June 1977;
JF 151, 30 June 1977)
California brickellbush
- Brickellia grandiflora (Hook.) PNFk
Nutt. (JF 228, 30 June 1977)
Tasselflower brickellbush
- Brickellia scabra (Gray) Nelson PNSbik
(JF 133, 25 June 1977)
Rough littleleaf brickellbush

Chaenactis stevioides H. & A. (SN ANSbik
327, 20 June 1973)
Steves dustymalden

Chrysothamnus depressus Nutt. PNSi
(JF 264, 16 May 1977)
Dwarf rabbitbrush

Chrysothamnus nauseosus (Pall.) PNSik
Britton (JF 121, 25 June 1977)
Rubber rabbitbrush

Chrysothamnus pulchellus (Gray) PNSbik
Greene (JWB, 24 July 1946)
Southwest rabbitbrush

Chrysothamnus viscidiflorus PNSbik
(Hook.) Nutt. (JF 263, 16 May
1977)
Douglas rabbitbrush

Cirsium pulchellum (Greene) Woot. BNFbk
& Standl. (JF 174, 30 June 1977)
Beautiful thistle

Conyza canadensis (L.) Cronquist ANFb
(JF 155, 30 June 1977)
Canada horseweed

Erigeron concinnus (H. & A.) Torr. PNFbk
& Gray (SN 313, 19 June 1973; JF
88, 13 July 1977; JF 141, 30 June
1977)

Erigeron divergens Torr. & Gray BNFbi
(SN 304, 1 June 1973; JWB NB-69,
19 June 1941; JWB NB-2, 21 May
1939; JF 13, 30 August 1977)
Spreading fleabane

Erigeron flagellaris Gray (JF 24, BNFbi
20 July 1977; JF 54, 22 July 1977)
Trailing daisy

Erigeron glabellus Nutt. (SN 163, BNFb
1 July 1972)
Smooth fleabane

Erigeron macranthus Nutt. (MW M-7; PNFb
JF 48, 14 July 1977; JF 55, 22
July 1977)

- Erigeron utahensis Gray (JF 29, 1 September 1977; JF 56, 22 July 1977; JF 138, 30 June 1977) PNFbi
Utah daisy
- Franseria acanthicarpa (Hook.) ANFik
Coville (JF 25, 19 July 1977; JF 60, 1 September 1977)
Annual borsage
- Gaillardia pinnatifida Torr. (SN 97, 10 June 1972) PNFb
Blanketflower
- Gutierrezia lucida Greene (JWB NB-30, 3 August 1940) PNSb
- Gutierrezia sarothrae (Pursh) PNSbik
Britt. & Rusby. (MW M-9, 2 September 1937; JWB, 24 July 1946; SN 157, 11 June 1972; SN 157; JMR 539-65, 21 August 1965; JF 255, 17 May 1977)
Broom snakeweed
- Haplopappus nuttallii Torr. & Gray (SN 157; MW 919-3157, 2 September 1938; JWB M-10; 23 June 1941) PNFbik
Nuttall goldenweed
- Haplopappus scopulorum (Jones) PNFbi
Blake (JF 12, 30 August 1977; JF 152, 30 June 1977)
Rocky mountain goldenweed
- Heterotheca villosa (Pursh) PNFbik
Shinners. (SN 177, 2 July 1972; JF 35, 1 September 1977; JF 68, 25 July 1977; JF 108, 25 June 1977)
Camphor weed
- Hymenopappus filifolius Hook. (SN 78, 9 June 1972; JF 44, 7 July 1977; JF 86, 13 July 1977; JF 89, 11 June 1977) PNFbk
Fineleaf hymenopappus
- Hymenopappus lugens Greene (JWB M-11, 17 June 1941) PNFb
Lugens hymenopappus

- Hymenoxys acaulis (Pursh) K. F. PNFb
Parker (JWB NB 23, 12 June 1939;
JF 45, 7 July 1977)
Stemless hymenoxys
- Hymenoxys bigelovii (Gray) K. F. PNFb
Parker (SN 301, 1 June 1973; JF
83, 13 June 1977)
Bigelow hymenoxys
- Hymenoxys ivesiana (Greene) Parker PNFb
(JWB NB 23; 12 June 1939)
Ives hymenoxys
- Hymenoxys Richardsonii (Hook.) PNFb
Cockerell (JF 235, 13 June 1977)
Pinque hymenoxys
- Lactuca pulchella (Pursh) PNFbk
Riddell. (SN 348, 22 July 1973;
JWB M-12, 28 July 1940; JF 6,
25 July 1977)
Chicory lettuce
- Machaeranthera grindelioides PNFbik
(Nutt.) Shinners (SN 137; MW; JF
143, 30 June 1977)
Gumweed machaeranthera
- Machaeranthera hansonii Nels. PNFi
(JF 11, 30 August 1977)
- Machaeranthera tephrodes (Gray) BNFb
Greene (JF 240, 30 June 1977)
Ashy machraeranthera
- Malacothrix sonchoides (Nutt.) ANFbi
Torr. & Gray (SN)
Sewthistle desert dandelion
- Psilostrophe sparsiflora (Gray) PNFb
A. Nels. (SN 161, 1 July 1972;
JF 114, 26 June 1977; MW M-13;
JF 139, 30 June 1977)
Greenstem paperflower
- Senecio longilobatus Benth. (JF PNFbi
67, 1 September 1977; JF 95,
11 June 1977)
Threadleaf groundsel

- Senecio multilobatus Torr. & Gray PNFbk
(JWB NB 70, 19 June 1941; JF
186, 3 June 1977)
Lobeleaf groundsel
- Senecio uintahensis (A. Nels.) PNFb
Greene (SN 100, 10 June 1972)
Kaiser weed
- Solidago canadensis L. (SN 172, PNFb
1 July 1972)
Canada goldenrod
- Solidago occidentalis (Nutt.) PNFb
Torr. & Gray (SN 350, 24 July
1973)
Western goldenrod
- Stephanomeria exigua Nutt. (JMR ANFb
345-65, 21 August 1965; SN, 3 July
1972; JF 105, 25 June 1977)
Small wirelettuce
- Stephanomeria tenuifolia (Torr.) PNFb
Hall (JDB 2502, 3 August 1977)
Slender wirelettuce
- Stephanomeria thurberi Gray (JF PNFb
53, 22 July 1977)
- Taraxacum officinale Weber. (SN PIFb
273, 17 May 1973)
Dandelion
- Tetradymia canescens DC. (SN 358, PNSbik
24 July 1973; JF 161, 30 June
1977)
Gray horsebush
- Townsendia incana Nutt. (JWB PNFb
M-16, 18 June 1941; SN 62, 9
June 1972; JF 206, 21 May
1977)
Hoary townsendia
- Verbesina encelioides (Cav.) ANFi
Benth. & Hook. (JF 1, 1 September
1977)
Golden crownbeard

Birds of the Monument

The bird fauna of Navajo National Monument as observed in the field, April 25 1977 to October 1 1977, consists of a total of 54 species representing 51 genera and 23 families. These figures when compared with the "Check-List of Birds, Navajo National Monument, Arizona" shows some differences (Table 7). As can be seen the differences are for the most part small and include additions to the existent checklist as well as the non-sighting of several species included on the checklist.

Checklist

The present list of bird species is arranged in phylogenetic order by family and genus. Bird identification follows the Check-List of North American Birds (American Ornithologists' Union,).

Table 7. Relationships existent between 1977 Bird list and Navajo National Monument published checklist.

Category	1977 Checklist	Navajo National Monument Checklist
No. of Families	23	21
No. of Genera	51	66
No. of Species	<u>57</u>	~~72~~ 143 ^{8/86-2nd ed. NAVA Bird Checklist}
No. of species addition to the existant checklist and/or not observed in 1977	12 ^{added spp.? in '77}	25 ^{not observed in '77?}

Birds		Vegetation Type			
		1	2	3	4
Cathartidae					
Cathartes aura	Turkey Vulture	X	X	X	X
Accipitridae					
Accipiter cooperi	Cooper's Hawk				X
Buteo jamaicensis	Red-tailed Hawk		X		
Aquila chrysaetos	Golden Eagle		X		
Falco sparverius	Sparrow Hawk		X		
Scolopacidae					
Tringa solitaria	Solitary Sandpiper				
Actitis macularia	Spotted Sandpiper				Both feeding by pond at I House
Columbidae					
Columba fasciata	Band-tailed Pigeon			X	X
Zenaidura macroura	Mourning Dove		X		
Strigidae					
Strix occidentalis	Spotted Owl				X
Caprimulgidae					
Chordeiles acutipennis	Lesser Nighthawk	X			
Apodidae					
Aeronautes saxatilis	White-throated Swift		X		X
Trochilidae					
Selasphorus platycercus	Broad-tailed Hummingbird				X
Archilochus alexandri	Black-chinned Hummingbird		X		X
Selasphorus rufus	Rufous Hummingbird		X		
Picidae					
Colaptes cafer	Red-shafted Flicker		X		X
Dendrocopos villosus	Hairy Woodpecker		X	X	X
Dendrocopos pubescens	Downy Woodpecker	X			X
Tyrannidae					
Tyrannus verticalis	Western Kingbird		X		
Myiarchus cinerascens	Ash-throated Flycatcher		X		
Sayornis saya	Say's Phoebe	X	X		
Empidonax oberholseri	Dusky Flycatcher	X	X		X
Nuttallornis borealis	Olive-sided Flycatcher		X		
Hirundinidae					
Tachycineta thalassina	Violet-green Swallow	X	X		X
Corvidae					
Corvus corax	Common Raven		X		
Gymnorhinus cyanocephalus	Pinyon Jay	X	X		
Aphelocoma coerulescens	Scrub Jay		X		X

		1	2	3	4
Paridae					
Parus atricapillus	Black-capped Chickadee	X			X
Parus gambeli	Mountain Chickadee	X	X	X	
Parus inornatus	Plain Titmouse	X	X		
Psaltiriparus minimus	Common Bushtit	X	X		
Sittidae					
Sitta carolinensis	White-breasted Nuthatch	X		X	X
Troglodytidae					
Thryomanes bewickii	Bewick's Wren				X
Salpinctes obsoletus	Rock Wren		X		
Catherpes mexicanus	Canyon Wren		X		
Turdidae					
Turdus migratorius	Robin	X			X
Hylocichla guttata	Hermit Thrush				X
Sialia mexicana	Western Bluebird		X		
Sylviidae					
Polioptila caerulea	Blue-gray Gnatcatcher		X		X
Regulus calendula	Ruby-crowned Kinglet			X	X
Laniidae					
Lanius ludovicianus	Loggerhead Shrike		X		
Vireonidae					
Vireo gilvus	Warbling Vireo				X
Parulidae					
Vermivora virginiae	Virginia's Warbler		X	X	X
Dendroica auduboni	Audubon's Warbler	X			
Dendroica nigrescens	Black-throated Gray Warbler	X	X		
Wilsonia pusilla	Wilson's Warbler				X
Thraupidae					
Piranga ludoviciana	Western Tanager			X	X
Fringillidae					
Pheucticus melanocephalus	Black-headed Grosbeak			X	X
Chlorura chlorura	Green-tailed Towhee		X		
Pipilo erythrophthalmus	Rufous-sided Towhee		X	X	X
Poocetes gramineus	Vesper Sparrow		X		
Chondestes grammacus	Lark Sparrow		X		
Amphispiza bilineata	Black-throated Sparrow		X		
Junco oreganus	Oregon Junco		X		
Junco caniceps	Gray-headed Junco		X		
Spizella passerina	Chipping Sparrow	X	X		

Mammals of the Monument

The mammal fauna of Navajo National Monument as observed in the field 1 May 1977 to 1 October 1977 consists of a total of 17 species representing 13 genera and 8 families. All species included on the list represent identifications made from actual sightings and/or captures. Mammal identification follows A Field Guide to the Mammals (Burt and Grossenheider, 1976).

Checklist

The present list of mammal species is arranged in phylogenetic order by family and genus.

Mammals

Vespertilionidae	
Myotis lucifugus	Little Brown Myotis
~~Euderma maculata~~	Spotted Bat
Canidae	
Canis latrans	Coyote
Urocyon cinereoargenteus	Gray Fox
Sciuridae	
Citellus variegatus	Rock Squirrel
Citellus spilosoma	Spotted Ground Squirrel
Eutamias quadrivittatus	Colorado Chipmunk
Heteromyidae	
Perognathus apache	Apache Pocket Mouse
Dipodomys ordii	Ord Kangaroo Rat
Cricetidae	
Peromyscus crinitus	Canyon Mouse
Peromyscus maniculatus	Deer Mouse
Peromyscus boylei	Brush Mouse
Peromyscus truei	Pinon Mouse
Neotoma stephensi	Steven's Woodrat
Erethizontidae	
Erethizon dorsatum	Porcupine
Leporidae	
Lepus californicus	Blacktail Jackrabbit
Sylvilagus auduboni	Desert Cottontail
Cervidae	
Odocoileus hemionus	Mule Deer
Mustelidae	
Taxidea taxus	Badger (1970, 1971)
Spilogale gracilis	Spotted Skunk (1971)
Felidae	
Felis concolor	Mountain Lion (1937, 1970, 1972)
Lynx rufus	Bobcat
Myotis	
Myotis cinerascens	mexican free-tail bat (1970)
Vesidae	
Vespa americana	? Black bear (1975)?
Procyonidae	
Procyon lotor	? Ringtail

Reptiles and Amphibians of the Monument

The reptile and amphibian fauna of Navajo National Monument as observed in the field 1 May 1977 to 10 October 1977 consists of a total of 9 species, 8 genera and 6 families. All species included on the list represent identification made from actual sighting and/or capture. Specimen identification follows A Field Guide to Western Reptiles and Amphibians (Stebbins, 1966).

Checklist

The present list of reptile and amphibian species is arranged in phylogenetic order by family and genus.

Amphibians

Bufonidae - True Toads
Bufo woodhousei

Woodhouse's Toad

Hylidae - Treefrogs
Hyla arenicolor

Canyon Treefrog

Pelobatidae
Scaphiopus hammondi

Western Spadefoot toad

Reptiles

Iguanidae - Iguanids
Sceloporus undulatus elongatus
Sceloporus graciosus
Uta stansburiana
Phrynosoma douglassi hernandesi

Northern Plateau Lizard
 Sagebrush Lizard
 Side-blotched Lizard
 Short-horned Lizard

Teiidae - Whiptails & Allies
Cnemidophorus velox

Plateau Whiptail

Colubridae - Colubrids
Pituophis melanoleucus deserticola Gopher Snake

Viperidae - Vipers
Crotalus viridis nuntius

Hopi Rattlesnake

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THE ALGAL FLORA OF
NAVAJO NATIONAL
MONUMENT

by
Jeffrey R. Johansen

INTRODUCTION

A variety of algal habitats can be found within the boundaries of the Betatakin, Keet Seel, and Inscription House Monuments. Betatakin Monument has three hanging gardens, one where the trail meets the canyon floor and two in the ruins themselves. These gardens are more xeric than those encountered elsewhere in the study. In fact, the one on the trail consists solely of moss and algae growing on a rock wall. Betatakin also has a spring below the ruins and an ephemeral creek in the canyon.

Keet Seel has a small spring that is located in a large hanging garden below the ruins. This hanging garden is much wetter than those of Betatakin and supports a lush growth of algae, mosses, and vascular plants. The spring water seeps into the ground immediately in front of the wall from which it emerges.

The trail into Inscription House has some interesting hanging gardens, but as they are outside of the monument boundaries they were not considered in this study. Therefore, the only habitat studied in Inscription House was the creek which originates in the valley below the ruins.

Algae from the Betatakin hanging gardens were cultured in a modified Bristol's solution (Deason and Bold, 1960) for one month. The algae of all other sites was examined upon returning from the field. Permanent diatom slides were prepared using standard acid oxidation techniques, the diatoms being mounted in Naphrax mountant. Non-diatoms were mounted in a glucose medium. All species were studied and identified using a Zeiss RA research microscope.

CONCLUSIONS

Eighty-eight taxa of algae were identified in this study, of which, 65 were Bacillariophyta, 19 were Cyanophyta, and 4 were Chlorophyta, Euglenophyta, or Chrysophyta. Achnanthes minutissima, Cymbella minuta var. silesiaca, Lyngbya limnetica, Microcoleus vaginatus, Navicula cryptocephala var. veneta, Nitzschia linearis, and Oscillatoria tenuis were the most widespread species, each occurring in all three segments of the monument. Betatakin canyon, with 59 algal taxa, had the greatest diversity, probably due to its having the greatest variety of environments. Keet Seel and Inscription House had 45 and 33 taxa, respectively.

Comparing this study with studies of similar environments (Rushforth, et al., 1976; Clark and Rushforth, in press) produces some interesting results. It was found in all three studies that species of Nitzschia were water loving diatoms, occurring in rare quantities, if at all, in the hanging gardens, while playing an important role in the creek populations. In the present study only one Nitzschia species, Nitzschia linearis, was seen in a hanging garden. Whereas, seven Nitzschia species were represented in Inscription House Creek. With the exception of Navicula contenta var. biceps and the four varieties of Navicula mutica, the Navicula species were also water loving. Most species of Navicula follow this general trend in the other studies as well, while Navicula mutica has been found to be a common soil diatom (Anderson and Rushforth, in press; Johansen and Rushforth, in press). Achnanthes are common in all the hanging gardens, this study having six different species of that genus. Melosira roeseana, a species which in Utah has been seen only in drip walls, was also a common diatom in the hanging gardens. The creeks

in this study have a large number of species which are unique to that particular environment, which trend also occurs in the other related studies.

This has been an interesting preliminary study. New taxa will probably be identified as this area is sampled and studied throughout the year. A comparative statistical analysis of the algae of hanging gardens in the Intermountain West would be a fascinating project for future research and hopefully will be undertaken soon.

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Table 1. Algal Distribution in Habitats by Division

Division	Hanging Garden	Spring	Creek
<u>Bacillariophyta</u>	34	27	36
<u>Cyanophyta</u>	13	9	12
<u>Chlorophyta</u> , <u>Euglenophyta</u> , and <u>Chrysophyta</u>	1	1	3
Total Species	48	37	51
Number of Restricted Species	15	4	29

Table 2. Algal Distribution in the Navajo National Monument

	Betatakin	Keet Seel	Inscription House
<u>Cyanophyta</u>			
Aphanocapsa grevillei	H		
Chlorogloea fritschii	HS	H	
Chroococcus turgidus	H	S	
Chroococcus varius			C
Gleocapsa punctata	H	H	C
Lyngbya limnetica	HS	HS	C
Merismopedia glauca			C
Microcoleus vaginatus	HS	H	C
Microcystis aeruginosa		S	C
Microcystis incerta	H	S	
Nostoc commune	H C	HS	
Oscillatoria angusta	H		
Oscillatoria angustissima	HS		
Oscillatoria geminata			C
Oscillatoria obscura			C
Oscillatoria subbrevis	H	H	C
Oscillatoria tenuis	HS	H	C
Phormidium angustissimum			C
<u>Chlorophyta</u>			
Chlorococcum humicola	H		

H = Hanging Garden S = Spring C = Creek

	Betatakin	Keet Seel	Inscription House
<u>Euglenophyta</u>			
Euglena fusca	C		
Trachelomonas abrupta	C		
<u>Chrysophyta</u>			
Tribonema bombycinum	SC		
<u>Bacillariophyta</u>			
Achnanthes coarctata	H	HS	
Achnanthes exigua		HS	
Achnanthes lanceolata	SC	HS	
Achnanthes lewisiana	HS		
Achnanthes microcephala	H	H	
Achnanthes minutissima	HSC	HS	C
Amphora veneta	C	S	
Caloneis bacillum		HS	
Caloneis ventricosa var. truncatula	C	S	
Cocconeis placentula var. lineata	S	HS	
Cyclotella meneghiniana	H		
Cymbella cesatii		HS	
Cymbella incerta var. naviculacea		S	
Cymbella mexicana var. janischii	S	HS	
Cymbella microcephala		H	
Cymbella minuta var. silesiaca	S	HS	C
Cymbella naviculaformis	C		
Cymbella turgida			C
Denticula elegans	H	HS	
Denticula elegans f. valida		HS	
Diatoma vulgare	H		

	Betatakin	Keet Seel	Inscription House
<u>Bacillariophyta</u> (continued)			
Eunotia pectinalis var. minor		H	
Epithemia muelleri	HS	H	
Epithemia zebra var. saxonica	C	HS	
Fragilaria brevistriata var. inflata		S	
Fragilaria leptostauron var. dubia		S	C
Fragilaria vaucheriae	HS		
Gomphonema angustatum	C		C
Hantschia amphioxys	H C	H	
Hantschia amphioxys f. capitata	H C	H	
Melosira roeseana	H	HS	
Navicula accomoda			C
Navicula arvensis			C
Navicula contenta var. biceps		H	
Navicula cryptocephala var. veneta	C	HS	C
Navicula cuspidata			C
Navicula elginensis	C		C
Navicula longicephala			C
Navicula minima		S	
Navicula mutica	H	H	
Navicula mutica var. cohnii	H		
Navicula mutica var. nivalis	H		
Navicula mutica var. undulata	H		
Navicula pupula			C
Navicula pupula var. rectangularis	C		
Navicula seminulum	C		

	Betatakin	Keet Seel	Inscription House
<u>Bacillariophyta</u> (continued)			
Navicula tripunctata var. schizonemoides		H	C
Neidium affine var. amphirhynchus	C		
Nitzschia communis	C		C
Nitzschia fonticola			C
Nitzschia frustulum	S	S	C
Nitzschia holsatica			C
Nitzschia linearis	S	HS	C
Nitzschia palea			C
Nitzschia paleacea	C		C
Pinnularia borealis	H	HS	
Pinnularia borealis var. rectangularis		H	
Pinnularia brebissonii			C
Pinnularia sudetica var. commutata	C		
Pinnularia sp.	HSC	H	
Rhopalodia gibba var. ventricosa	C		
Stauroneis anceps	C		
Stauroneis phoenicenteron	C		
Surirella ovalis	C		C
Surirella spiralis	S	S	