W. H. Middleton
Western State College
Of Colorado . . . . . Gunnison, 81230
DIVISION OF NATURAL SCIENCES
AND MATHEMATICS
Department of Biology

GUNNISON, CO
MAR 28'68
81230
U.S. POSTAGE
12¢
P.B. 393313

Dr. Robert Behnke

Colorado Cooperative Fisheries Unit

Colorado State University

Fort Collins, Colorado 80521

-shocker

CODING FORM

Objects

Characters and Character states

0 0 0 0 0 0 0 0 4 1 0 5 2 0 5 2

3 0 0 0 0 0 0 0 0 0 0 4 1 9 9

4 0 0 0 0 0 0 0 0 9 9 9 9

9 9 9 9 9

Suckers' R. J. Behnke May 1967 25

objects, 9 characters

etc. - Fish. Wyo - Utah - Colo. N. Mex.
- characters - range - variability - C. catost. C. lesp-pin.
C. comm. - P. dec. hybrids.
P. plat.

P. platyrynchus pelvic appendage
- well developed

(pelvic - appendage varies - even among pops.)

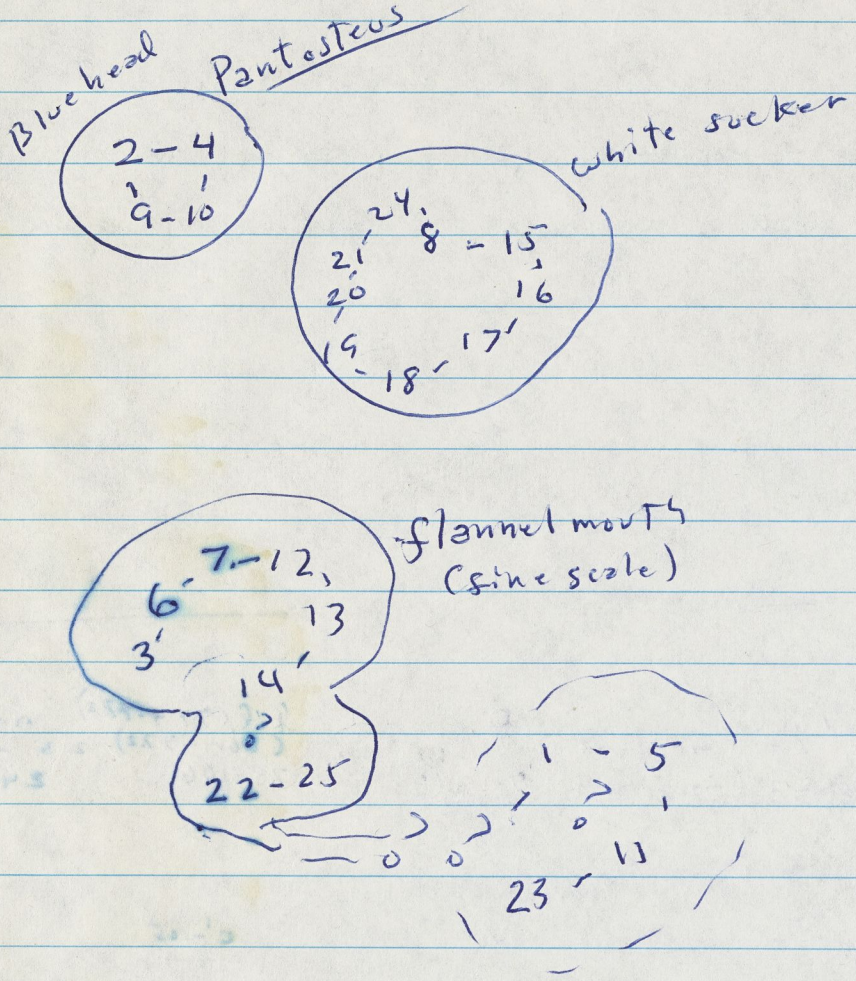
P. x P. of Colo. - headwater fish peduncle handle slenderer from other drainages - evidence of hybrids w/ discobolus.

- caudal peduncle
- sharper rakes -
- lips - head - pre dorsal scales.
- falcate fins.

C. platyrhynchus Vert. D. L.l. (77.4-87.2) rakes
o Ther (40.1-42.7) (9.8-11.5) (86.4-97.2) 23 - 37
Colo. R. 38-43 (40.3-41.4) 9-13 (9.8-10.2) 78-106 24-36

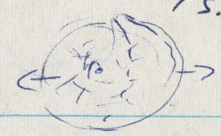
discobolus

			predorsal scales			
			36 (42-53)		(86-106)	
				9.3-11.0	(90-105)	
					(86-90)	
Colo. upper	41-46	(43.3-44.7)	9-12	(10.2-11.0)	85-122	28-43
					(86-91)	
Colo. middle	42-46	(42.9-43.7)	9-11	(10.0-10.3)	80-98	28-35
			47.5-	70		
			(50-60)			


Bluehead
Pantosteus
2-4
9-10
white sucker
24
8-15
21
20
16
19
18
17
flannelmouth
(fine scale)
6
7-12
3
13
14
22-25
1-5
23

K8 vertebrae

K9 - D. base/S.L.



K1 No. scales in lateral line

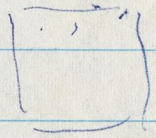
A	B	C	D
to 77 72	78 - 89	90 - 100	101 →
1	2	3	

K2 No scales above lat. line

A	B	C
to 16	17 - 20	21 →

K3 No. Dorsal fin Rays

A	B	C	D
10	11	12	13



K4 No. Pectoral fin Rays

A	A B	B	C
13	14	15	16 →

N=2 17 ??

vert.	
41-42	43-44
A	B

K5 No. Ventral fin Rays

A	B	C	D
8	9	10	11 → 12

K6 No. Gill rakers

A	B	C
to 25	26-29	30 →

N=3

K7 Mouth shape lateral notch present (A); absent (B)

Ks Vertebree

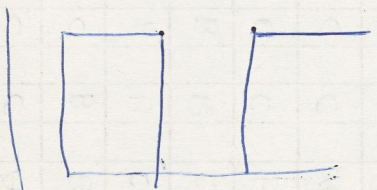
41-42	43-44
A	B

Kg Dorsal fase / S.L.

>135	136 – 148	~~146~~ 150 – 169	170 →
A	B	C	D
1	2	3	4

CODING FORM

Objects	Characters and Character states								
	1	2	3	4	5	6	7	8	9
1	B	B	C	D	C	B	B	A	C
2	C	B	A	B	A	C	A	A	B
3	D	C	D	B	C	A	B	A	D
4	D	B	A	A	A	C	A	B	D
5	B	B	B	C	C	A	B	A	A
6	D	C	D	D	D	A	B	B	D
7	C	C	C	C	C	A	B	B	C
8	A	A	A	C	B	B	B	B	C
9	C	B	A	B	B	C	A	B	B
10	C	B	B	B	B	C	A	B	C
11	A	A	B	C	C	B	B	A	C
12	D	C	C	C	C	A	B	B	D
13	D	C	D	C	C	A	B	∅	D
14	D	C	C	D	D	A	B	B	B
15	A	A	B	D	C	A	B	B	C
16	A	A	B	D	C	A	B	A	C
17	A	A	B	D	B	A	B	B	B
18	A	A	C	D	C	A	B	B	C
19	A	A	B	C	B	A	B	B	B
20	A	A	C	D	C	A	B	B	A
21	A	A	B	D	B	A	B	A	C
22	D	C	A	D	C	A	B	B	A
23	B	A	A	D	C	B	B	B	A
24	A	A	B	D	C	A	B	B	C
25	D	B	B	D	C	A	B	B	A



21 16 1917

A. Williams
Outline

Purpose

To make a comparison of the relative abundance of three species of sucker in a variety of habitats along the inlet streams and Blue Mesa Reservoir.

Methods and Materials

A. Collecting methods
   1. Live traps
   2. Gill net
   3. Shocker
B. Intensive collecting in each area for short periods of time
C. Mark and release
   1. Alkins and Peterson tags (each species will have different type of tag)
   2. Control necessary to see mortality rate of similarly handled but untagged fish
   3. Mark all sizes of fish as possible with type of tags used
D. Weight and measurements taken
E. Lincoln-index used to determine population size

Data

A. Description of different habitats
   1. Streams
      a. Direction of flow
      b. Rate of flow
      c. Depth of traps in stream
   2. Inlets
   3. Area between inlets
B. Physical character of water
   1. Temperature
   2. pH
   3. Oxygen content
   4. Salinity
   5. Turbidity
   6. Depth of traps in lakes and inlet
C. Density of three spedies in relation to physical characters of water
D. Age differences
   1. Density relative to age
   2. Morphological differences due to age

Results

A. Numbers of each species in each type of habitat
B. Note conditions that favor the abundance of each species

Revised Outline

BILL MIDDLETON
C/O DR. RICHARD MARQUARDT
ZOOLOGY DEPT.
WESTERN STATE COLLEGE
GUNNISON, COLO

Taxonomy and Population Dynamics of Catostomidae
(Tentative outline of combined study)
- IN BLUE MESA RESERVOIR AND MAJOR TRIBUTARIES

I. Introduction.
  A. Statement of the problem
    1. There is an apparent increase in the number of suckers in Blue Mesa resevoir. SINCE IMPOUNDMENT
    2. There exists an apparent inaccuracy inavailable descriptive literature on the suckers.
    3. It ~~is also apparent~~ APPEARS that a hybrid population exists.
  B. Description of the area.
    1. Historical environment of the area prior to impoundment will be indicated.
    2. Post-impoundment records of environment will be indicated such as;
      a. water temperature
      b. O^2
      c. rainfall
      d. turbidity
      e. depth
      f. bottom type
      g. season of the year
      h. collection bias
      plus pH, SALINITY, RATE OF FLOW STREAM & LAKE
    3. ~~Description~~ INVESTIGATION of tributaries ~~as a source of preference in habitat will be indicated.~~ IN RELATION TO SPECIES HABITAT PREFERENCE
    4. Description of the physical characteristics of the lake will be noted as well as the tributaries. For example;
      a. littoral zone
      b. benthic zone
      c. physiography
    5. Flora which is abundant in the collection areas will be identified.
  C. Review of previous investigations.
    1. discussion of pre-impoundment studies done in the area.
    2. discussion of collections made by these above studies.
    3. discussion of original description of types specimens.
II. Materials and Methods.
  A. General methods.
    1. The methods will be described for gill netting.
    2. The methods of shocking will be described for stream and lake collections. This will require both boom and back-pack shocking.
    3. The methods of preservation will be described with reference to color and tissue.
    4. An experimental design with statistical evidence ~~will be~~ furnished to provide preference as to choice of collection techniques with reference to methods used, area, depth, time of day.
    5. Data recorded at the time of collection will include weight and sizes of the specimens, environmental factors suchs as water conditions and weather, designation of collection area.
  B. Special methods.
    1. Discussion of parameters used by Beckman and Ellis.

II. Materials and Methods
B. Special methods.-cont.
2. Discussion of parameters which are currently being used by Dr. Robt. Bentke.
3. Establish parameters to be used in this study in cooperation with Dr. Bentke.
4. Provide experimental design with statistical evidence for the use of these parameters.

III. Observations.
A. Collections
1. Establish identity of species for the Blue Mesa and tributaries.
2. Verification of species by Colorado Cooperative Fisheries Research Unit.
3. Investigation of variant forms for the possibility of hybridization ~~if this exists~~.
4. Investigate polymorphic variation due to sex, age, season, environment.
5. Describe variants statistically for evidence of overlap, clines, and other relationships.

B. Totals and environmental relationships. AND AGE
1. Sample size totals and species structure of each.
2. Correlation of species and numbers as related to environmental changes.
3. Temporal/spatial relationships of species ~~and numbers.~~

IV. Results.
A. Annotated list of species*
B. Annotated list of variants*
C. Annotated list of hybrids*
D. Phylogenetic relationships

V. Discussion.

Note: This will be a combined study for two Master's Theses. The study is being conducted in this manner to avoid duplication of effort ~~due to the fact that~~ AS time is a limiting factor.

MIDDLETON
WILLIAMS
CZEWKUSKH

* In terms of parameters chosen for this study.

CHARACTER ANALYSIS SHEET - COLORADO COOPERATIVE FISHERY UNIT

Species Colo. R. Suckers Locality Gunnison R. near Delta

Collected by _____ Date _____

Cat. # _____ Measurements by _____ Date Feb. 68

Specimen #

Total L.								
Standard L	420	312	365	392				
Body D								
Head L								
Orbit L								
Upper Jaw L								
Dors. Orig. to Snt. tip								
Dorsal fin basal L								
Dorsal fin depressed L								
Adip. fin depressed L								
Caudal peduncle D								
Caudal peduncle L								
Vertebrae								
1st Arch gill rakers (up)								
(lower)								
(total)	28	25	25	24 or 25				
Branchiostegal rays right								
(left)								
Dorsal Rays								
Anal rays								
Pectoral fin rays								
Pelvic fin rays								
Scales in lateral line	87+2	120+4						
Scales above lateral line	15	25	24	26				
Scales 2 rows above lat.								
Scales 2 rows below lat.								
(around)								
Pyloric caeca								
Dentition								
Anal fin base								
Anal fin depressed								
Dors. Origin - caudal	11 P (13 or 10)	12 P or 13	12 P or 13	12 - 13				
P fin - snout								
P fin caudal								
Pre orbital - Post orbital								

Study genus Catostomus

subgenera Catostomus & Pantosteus

of Gunnison R. Colo. — what sp. do we have?

N = 25

Beckman D 10-11 95-115 scales

discobolus

catostomus D 10-12 = 16-23 90-118

latippinis D 11-13 scales 17-19 98-120

Pantosteus N = 4

					range
l.l.	93	93	99	105	93-105
above	19	19	19	18	18-19
D	10	10	10	11	10-11
P	14	13	14	14	13-14
V	8	8	9	9	8-9
rakers	32	33	32	36	32-36

flannel mouth?

N = 7 catostomus

?							
98	101	103	107	111	114	117	121
22	28	23	19	24	25	25	21
12	12	13	11	13	13	12	10
15	15	15	16	16	14	17	17
10	10	10	10	11	10	12	10
23	24	23	23	24	23	25	23

101-121

19-28

D. 10-13 x̄ = 12.0

P 14-17 x̄ 15.7

V 10-12 x̄ 10.4

23-25 x̄ 23.4

Catostomus white

flannel mouth ?! — Pantosteus — Pantosteus

	#15									flannel mouth				Pantosteus		Pantosteus	
l.l. 59	62	63	64	64	64	66	68	69	73	80	81	85	93	93	98	99
12	10	12	13	12	12	15	13	10	15	15	18	19	19	19	22	
D 11	11	12	11	12	11	10	11	11	11	10	11	12	10	11	12	
P 16	16	16	15	16	16	15	16	16	15	16	15	16	14	14	15	
V 10	10	10	9	10	10	9	9	9	10	10	10	10	9	9	10	
rakers 23	17	25	20	23	24	26	22	25	27	27	25	26			23	

17: 184 mm smallest specimen

59-69

above 10-15 (12-13)

D 10-12 x̄ 11.1

P 15-16 15.8

V 9-10 9.5

rakers → 25

73-85

15-19 (17)

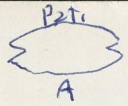
10-12 11.0

15-16

10

25-27

A 13 C
<7 7 78-89 90-100
>101



Cat.

an A B C
→16 17-20 21-

A B C D
D 10 11 12 13
P 13 14 15 16
V 8 9 10

. naku
>25
26-29
30-

CODING FORM

Objects ① ② l. l. above

Characters and Character states

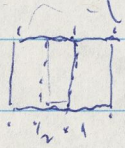
	l.	l. above	P	A	P	V	Rakers	Vert.	Mouth
1	85	19	12	7	16	10	~~26~~ ~~32~~	~~P~~ C	
2	99	19	10	7	14	8	32	P	
3	114	25	13	7	15	10	~~23~~	C	
4	105	18	10	7	13	8	33	P	
5	81	18	11	7	15	10	25	C	
6	111	24	13	7	15	10	24	C	
7	98	22	12	7	15	10	23	C	
8	66	15	10	7	15	9	26	C	
9	93	19	10	7	14	9	31	P	
10	93	19	11	7	14	9	30	P	
11	73	15	10	7	15	10	27	C	

Whitesucker Lezsure

							Hammond			
*	28	26	30	54	29	48	36	38	45	62
l.l.	58	59	60	63	65	70	68	65	69	64
above	11	12	13	11	12	12	11	11	14	11
D	10	12	11	11	11	11	11	11	12	11
P	14	16	16	16	15	16	16	14	16	15
V	9	9	10	10	10	10	10	9	11	10
nekes	24	22	25	19	21	20	(27)	23	23	22
vert.										
size	185	273	305	217	218	258	215	180	268	309
D.B.	27	47	43	33	36	35	30	24	42	45
%	146	172	141	152	165	131				

Pontostens

*	(?) 46	27	55	(?) 66	47	53	49	51	31	52
l.l.	(93)	88	89	(94)	97	98	(100)	105	108	111
above	14	22	21	20	20	21	19	21	19	20
D.	12	11	10	11	10	11	11	11	10	11
P.	16	14	15	14	15	14	14	14	15	14
V.	10	10	10	8	9	9	9	9	9	9
nekes	(27)	33	29	(26)	36	31	(23)	35	29	32
vert.										
size	229	222	226	190	220	210	200	269	257	258
D.B.	33	30	30	29	29	33	28	46	33	42
%	144	135	133	153	132	157	140	171	128	157



→ 1, 5, 11, 23, 22, 25
(14)

	mm.			pelvic append. ↓	pelvic append ↓	pelvic append ↓				
size	212	184	240	225	236	224	212	247	252	
spec. #	~~24~~	15	20	19	18	16	8	21	17	range
l.l.	~~50~~9	62	63	64	64	66	~~66~~	~~68~~	~~69~~	59-69
above	~~12~~	10	12	13	12	12	15	13	10	10-15 (12-13)
D.	11	11	12	11	12	11	10	11	11	10-12 ($\bar{x}$ 11.1)
P	16	16	16	15	16	16	15	16	16	15-16 ($\bar{x}$ 15.8)
V	10	10	10	9	10	10	9	9	9	9-10 (9.5)
nakes	23	17 *1	25	20	23	24	26	22	25	(?) 17-26 20-26
vert.	43	43-44	43	43	43	42	43	41	44	(43)
db/s.l.%	165	152	125	142	161	152	151	154	139	

*1 smallest specimen, prob. not all developed

white sucker

These are species Catostomus (Catostomus) commersoni

size	308	287	268	209		277	229	374	~~426~~
spec. #,	9	10	2	4	not in order	11	23	5	1
ll.	93	93	99	105	93-105	73	80	81	85
above	19	19	19	18	18-19	15	15	18	19
D.	10	10	10	11	10-11	11	10	11	12
P.	14	13	14	14	13-14	15	16	15	16
V.	8	8	9	9	8-9	10	10	10	10
	140	150	139	178	32-36 blue head sucker (43.5)	152	118	118	162
nakes	32	33	32	36		27	27	25	26
vert.	44	44	42?	44		41?	43	42	42

These are C. (Pantosteus) discobolus

	320	~~264~~	366	~~259~~	~~332~~	~~258~~	~~387~~	~~221~~	pelvic appendage
	7	12	13	25	6	3	(14)	(22)	
d.l.	98	101	103	107	114	114	117	121	98-121
above	22	28	23	(19)	24	25	25	(21)	19-28 (23-28)
D.	12	12	13	(11)	13	13	12	(10)	10-13 (12-13)
P.	15	15	15	16	16	14	(17)	(17)	14-17
V.	10	10	10	10	11	10	12	10	10-12
nakes	23	24	23	23	24	23	25	23	2-3-~~5~~
vert.	43-44	44	—	43	44	41-43	44	(43.5)	
	169	185	178	120	178	178	142	131	

+? C. catostomus

C. latipinnis

latipinnis - 5-8 rows warts on upper lip || — caerulonus

D. foliata 11-13 —— 10-12 usually 10

caudal peduncle - pencil-like —— stout

	17-19	——	16-23
scales	98-120	——	90-118

flannel mouth ! 49 3358
46,66,-

♂	33	34	67	35	32	50
l.l.	88	98	98	102	105	109
abm.	18	21	19	24	21	23
D.	11	12	10	12	13	12
P.	16	16	17	16	17	16
V.	11	11	8	10	10	10
rakenv.	26	23	21	22	21	25
vert:						
size	310	378	190	347	322	364
D.B.	51	63	24	56	59	67
?.	164	166	126	162	183	181
		Hammonds				
♂	37	39	42	56	58	61
l.l.	114	112	129	102	80	96
abm	19	20	25	24	19	
D	10	10	12	12	12	
P	16	15	16	15	16	
V	10	16	10	10	10	
rakenv.	24	24	27	25	25	
vert.						
S.L.	247	215	422	388	297	
D.bas	31	26	64	57	47	

60

Armands Pantastes

#	40	41	43	44	57	59	60
l. l.	98	118	108	96	109	90	77
above	20	22	22	23	21	22	16
D,	10	11	12	11	11	11	10
P,	15	15	16	14	15	14	16
V.	9	8	10	10	9	9	10
nakin	34	33	36	34	36	37	28
s.t.	233	239	234	212	258	340	247
D. bene	32	33	37	29	29	37	28

3.2/2 : 3

R. J. BEHNKE

25 suckers from Gunnison R. Colo.

CODING FORM

Objects	Characters and Character states								
	1	2	3	4	5	6	7	8	9
1	2	2	3	4	3	2	2	1	3
2	3	2	1	2	1	3	1	1	2
3	3	3	4	2	3	1	2	1	4
4	3	2	1	1	1	3	1	2	4
5	2	2	2	3	3	1	2	1	1
6	3	3	4	4	4	1	2	2	4
7	3	3	3	3	3	1	2	2	3
8	1	1	1	3	2	2	2	2	3
9	3	2	1	2	2	3	1	2	2
10	3	2	2	2	2	3	1	2	3
11	2	1	2	3	3	2	2	1	3
12	3	3	3	3	3	1	2	2	4
13	3	3	4	3	3	1	2	Ø	4
14	3	3	3	5	5	1	2	2	2
15	1	1	2	4	3	1	2	2	3
16	1	1	2	4	3	1	2	1	3
17	1	1	2	4	2	1	2	2	2
18	1	1	3	4	3	1	2	2	3
19	1	1	2	3	2	1	2	2	2
20	1	1	3	4	3	1	2	2	1
21	1	1	2	4	2	1	2	1	3
22	3	3	1	5	3	1	2	2	1
23	2	1	1	4	3	2	2	2	1
24	1	1	2	4	3	1	2	2	3
25	3	2	2	4	3	1	2	2	1

SUCKERS R.J.BEHNKE 7 MAY 1967 25 OBJECTS 9 CHARACTERS

NCS	0	0	0	0	0	3	0	0	0
N	0	0	4	5	5	0	0	0	4
K	0	0	1	2	2	0	0	0	1

MATRIX PARAMETERS
0.400 0.000 0.000

MAIN INPUT DATA

OBJ. NO.	CHARACTER STATES
1	223432 213
2	321213 112
3	334231 214
4	321113 124
5	222331 211
6	334441 224
7	333331 223
8	111322 223
9	321223 122
10	322223 123
11	212332 213
12	333331 224
13	334331 204
14	333551 222
15	112431 223
16	112431 213
17	112421 222
18	113431 223
19	112321 222
20	113431 221
21	112421 213
22	331531 221
23	211432 221

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24 112431 223

25 322431 221

IDENTICAL OBJECT PAIRS (THE LATTER OBJECT OF EACH PAIR IS ELIMINATED FROM THE STUDY.)

15 AND 24

SUCKERS R.J.BEHNKE 7 MAY 1967 25 OBJECTS 9 CHARACTERS

SIMILARITY RATIOS

2	1	0.31111	9	3	1	0.48889	9	3	2	0.35556	9	4	1	0.17778	9	4	2	0.72222	9
4	3	0.30000	9	5	1	0.70000	9	5	2	0.38889	9	5	3	0.50000	9	5	4	0.20000	9
6	1	0.41111	9	6	2	0.13333	9	6	3	0.74444	9	6	4	0.33333	9	6	5	0.33333	9
7	1	0.54444	9	7	2	0.23333	9	7	3	0.70000	9	7	4	0.31111	9	7	5	0.48889	9
7	6	0.75556	9	8	1	0.44444	9	8	2	0.26667	9	8	3	0.31111	9	8	4	0.34444	9
8	5	0.36667	9	8	6	0.38889	9	8	7	0.54444	9	9	1	0.23333	9	9	2	0.83333	9
9	3	0.27778	9	9	4	0.77778	9	9	5	0.31111	9	9	6	0.26667	9	9	7	0.37778	9
9	8	0.43333	9	10	1	0.34444	9	10	2	0.70000	9	10	3	0.32222	9	10	4	0.75556	9
10	5	0.33333	9	10	6	0.31111	9	10	7	0.48889	9	10	8	0.43333	9	10	9	0.86667	9
11	1	0.76667	9	11	2	0.27778	9	11	3	0.47778	9	11	4	0.13333	9	11	5	0.71111	9
11	6	0.31111	9	11	7	0.53333	9	11	8	0.65556	9	11	9	0.20000	9	11	10	0.33333	9
12	1	0.47778	9	12	2	0.18889	9	12	3	0.76667	9	12	4	0.37778	9	12	5	0.48889	9
12	6	0.82222	9	12	7	0.93333	9	12	8	0.47778	9	12	9	0.33333	9	12	10	0.42222	9
12	11	0.46667	9	13	1	0.46250	8	13	2	0.21250	8	13	3	0.93750	8	13	4	0.30000	8
13	5	0.50000	8	13	6	0.87500	8	13	7	0.85000	8	13	8	0.41250	8	13	9	0.25000	8
13	10	0.30000	8	13	11	0.47500	8	13	12	0.92500	8	14	1	0.38889	9	14	2	0.22222	9
14	3	0.51111	9	14	4	0.22222	9	14	5	0.35556	9	14	6	0.71111	9	14	7	0.75556	9
14	8	0.33333	9	14	9	0.33333	9	14	10	0.31111	9	14	11	0.28889	9	14	12	0.71111	9
14	13	0.60000	8	15	1	0.53333	9	15	2	0.13333	9	15	3	0.40000	9	15	4	0.22222	9
15	5	0.50000	9	15	6	0.54444	9	15	7	0.65556	9	15	8	0.75556	9	15	9	0.27778	9
15	10	0.41111	9	15	11	0.65556	9	15	12	0.58889	9	15	13	0.48750	8	15	14	0.50000	9
16	1	0.64444	9	16	2	0.24444	9	16	3	0.51111	9	16	4	0.11111	9	16	5	0.61111	9
16	6	0.43333	9	16	7	0.54444	9	16	8	0.64444	9	16	9	0.16667	9	16	10	0.30000	9
16	11	0.76667	9	16	12	0.47778	9	16	13	0.48750	8	16	14	0.38889	9	16	15	0.88889	9
17	1	0.41111	9	17	2	0.23333	9	17	3	0.30000	9	17	4	0.21111	9	17	5	0.48889	9
17	6	0.46667	9	17	7	0.53333	9	17	8	0.74444	9	17	9	0.40000	9	17	10	0.40000	9
17	11	0.53333	9	17	12	0.48889	9	17	13	0.37500	8	17	14	0.54444	9	17	15	0.87778	9
17	16	0.76667	9	18	1	0.60000	9	18	2	0.08889	9	18	3	0.44444	9	18	4	0.17778	9
18	5	0.43333	9	18	6	0.58889	9	18	7	0.72222	9	18	8	0.71111	9	18	9	0.23333	9
18	10	0.34444	9	18	11	0.58889	9	18	12	0.65556	9	18	13	0.53750	8	18	14	0.56667	9
18	15	0.93333	9	18	16	0.82222	9	18	17	0.81111	9	19	1	0.35556	9	19	2	0.26667	9
19	3	0.33333	9	19	4	0.23333	9	19	5	0.54444	9	19	6	0.41111	9	19	7	0.58889	9
19	8	0.80000	9	19	9	0.43333	9	19	10	0.43333	9	19	11	0.58889	9	19	12	0.54444	9
19	13	0.43750	8	19	14	0.51111	9	19	15	0.82222	9	19	16	0.71111	9	19	17	0.94444	9
19	18	0.75556	9	20	1	0.48889	9	20	2	0.08889	9	20	3	0.40000	9	20	4	0.13333	9
20	5	0.54444	9	20	6	0.54444	9	20	7	0.61111	9	20	8	0.60000	9	20	9	0.23333	9
20	10	0.23333	9	20	11	0.47778	9	20	12	0.61111	9	20	13	0.48750	8	20	14	0.56667	9
20	15	0.82222	9	20	16	0.71111	9	20	17	0.81111	9	20	18	0.88889	9	20	19	0.75556	9
21	1	0.58889	9	21	2	0.27778	9	21	3	0.45556	9	21	4	0.14444	9	21	5	0.55556	9
21	6	0.40000	9	21	7	0.48889	9	21	8	0.70000	9	21	9	0.22222	9	21	10	0.35556	9
21	11	0.71111	9	21	12	0.42222	9	21	13	0.42500	8	21	14	0.36667	9	21	15	0.83333	9
21	16	0.94444	9	21	17	0.82222	9	21	18	0.76667	9	21	19	0.76667	9	21	20	0.65556	9
22	1	0.32222	9	22	2	0.28889	9	22	3	0.55556	9	22	4	0.35556	9	22	5	0.51111	9
22	6	0.66667	9	22	7	0.68889	9	22	8	0.45556	9	22	9	0.43333	9	22	10	0.32222	9
22	11	0.33333	9	22	12	0.68889	9	22	13	0.65000	8	22	14	0.73333	9	22	15	0.54444	9
22	16	0.43333	9	22	17	0.53333	9	22	18	0.50000	9	22	19	0.50000	9	22	20	0.61111	9
22	21	0.37778	9	23	1	0.55556	9	23	2	0.20000	9	23	3	0.28889	9	23	4	0.24444	9
23	5	0.58889	9	23	6	0.43333	9	23	7	0.43333	9	23	8	0.66667	9	23	9	0.34444	9
23	10	0.23333	9	23	11	0.65556	9	23	12	0.43333	9	23	13	0.36250	8	23	14	0.38889	9
23	15	0.64444	9	23	16	0.53333	9	23	17	0.63333	9	23	18	0.60000	9	23	19	0.57778	9
23	20	0.71111	9	23	21	0.47778	9	23	22	0.65556	9	25	1	0.53333	9	25	2	0.35556	9
25	3	0.46667	9	25	4	0.40000	9	25	5	0.72222	9	25	6	0.61111	9	25	7	0.65556	9
25	8	0.42222	9	25	9	0.50000	9	25	10	0.52222	9	25	11	0.43333	9	25	12	0.65556	9
25	13	0.56250	8	25	14	0.61111	9	25	15	0.66667	9	25	16	0.55556	9	25	17	0.65556	9

SUCKERS R.J.BEHNKE 7 MAY 1967 25 OBJECTS 9 CHARACTERS SIMILARITY RATIOS

25 18 0.60000 9 25 19 0.60000 9 25 20 0.71111 9 25 21 0.50000 9 25 22 0.76667 9
25 23 0.64444 9

SUCKERS R.J.BEHNKE 7 MAY 1967 25 OBJECTS 9 CHARACTERS

L= 1 C(1)= 0.94444

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS		R(1)
16 21	0.94444	1	1	(21, 16)(

MOAT = 0.05556 NEXT PAIRS TO JOIN (16, 15) (

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS		R(1)
17 19	0.94444	1	1	(19, 17)(

MOAT = 0.06667 NEXT PAIRS TO JOIN (17, 15) (

SINGLE MEMBER CLUSTERS (20)
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 18, 20, 22, 23, 25,

SUCKERS R.J.BEHNKE 7 MAY 1967 25 OBJECTS 9 CHARACTERS

L= 2 C(2)= 0.93750

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS		R(2)
3 13	0.93750	1	1	(13, 3)(

MOAT = 0.01250 NEXT PAIRS TO JOIN (13, 12) (

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS		R(2)
16 21	0.94444	1	1	

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS		R(2)
17 19	0.94444	1	1	

SINGLE MEMBER CLUSTERS (18)
1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15, 18, 20, 22, 23, 25,

SUCKERS R.J.BEHNKE 7 MAY 1967 25 OBJECTS 9 CHARACTERS

L= 3 C(3)= 0.93333

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS		R(3)
3 13	0.93750	1	1	
CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS		R(3)
7 12	0.93333	1	1	(12, 7)(

MOAT = 0.00833 NEXT PAIRS TO JOIN (13, 12) (

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS		R(3)
15 18	0.93333	1	1	(18, 15)(

MOAT = 0.04444 NEXT PAIRS TO JOIN (16, 15) (20, 18) (

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS		R(3)
16 21	0.94444	1	1	
CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS		R(3)
17 19	0.94444	1	1	

SINGLE MEMBER CLUSTERS (14)
1, 2, 4, 5, 6, 8, 9, 10, 11, 14, 20, 22, 23, 25,

SUCKERS R.J.BEHNKE 7 MAY 1967 25 OBJECTS 9 CHARACTERS

L= 4 C(4)= 0.92500

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS		R(4)
3 7 12 13	0.92500	3	6	(13, 12)(

MOAT = 0.05000 NEXT PAIRS TO JOIN (13, 6) (

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS		R(4)
15 18	0.93333	1	1	

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS		R(4)
16 21	0.94444	1	1	

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS		R(4)
17 19	0.94444	1	1	

SINGLE MEMBER CLUSTERS (14)
1, 2, 4, 5, 6, 8, 9, 10, 11, 14, 20, 22, 23, 25,

SUCKERS R.J.BEHNKE 7 MAY 1967 25 OBJECTS 9 CHARACTERS

L= 5 C(5)= 0.88889

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS		R(5)
3 7 12 13	0.92500	3	6	

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS		R(5)
15 16 18 20 21	0.88889	4	10	(16, 15)(20, 18)(

MOAT = 0.01111 NEXT PAIRS TO JOIN (17, 15) (

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS		R(5)
17 19	0.94444	1	1	

SINGLE MEMBER CLUSTERS (13)
1, 2, 4, 5, 6, 8, 9, 10, 11, 14, 22, 23, 25,

SUCKERS R.J.BEHNKE 7 MAY 1967 25 OBJECTS 9 CHARACTERS

L= 6 C(6)= 0.87778

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS		R(6)
3 7 12 13	0.92500	3	6	

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS		R(6)
15 16 17 18 19 20 21	0.87778	6	21	(17, 15)(

MOAT = 0.07778 NEXT PAIRS TO JOIN (19, 8) (

SINGLE MEMBER CLUSTERS (13)
1, 2, 4, 5, 6, 8, 9, 10, 11, 14, 22, 23, 25,

SUCKERS R.J.BEHNKE 7 MAY 1967 25 OBJECTS 9 CHARACTERS

L= 7 C(7)= 0.87500

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS		R(7)
3 6 7 12 13	0.87500	4	10	(13, 6)(

MOAT = 0.11944 NEXT PAIRS TO JOIN (14, 7) (

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS		R(7)
15 16 17 18 19 20 21	0.87778	6	21	

SINGLE MEMBER CLUSTERS (12)
1, 2, 4, 5, 8, 9, 10, 11, 14, 22, 23, 25,

SUCKERS R.J.BEHNKE 7 MAY 1967 25 OBJECTS 9 CHARACTERS

L= 8 C(8)= 0.86667

CLUSTER MEMBERSHIP — C-VALUE CONNECTEDNESS R(8)
3 6 7 12 13 — 0.87500 5 10
INTERNAL CONNECTIONS AT (0.86667) — INTERNAL CONNECTIONS AFTER (0.86667)
(13, 7) (

CLUSTER MEMBERSHIP — C-VALUE CONNECTEDNESS R(8)
9 10 — 0.86667 1 1 (10, 9)(
MOAT = 0.03333 NEXT PAIRS TO JOIN (9, 2) (

CLUSTER MEMBERSHIP — C-VALUE CONNECTEDNESS R(8)
15 16 17 18 19 20 21 — 0.87778 6 21

SINGLE MEMBER CLUSTERS (10)
1, 2, 4, 5, 8, 11, 14, 22, 23, 25,

SUCKERS R.J.BEHNKE 7 MAY 1967 25 OBJECTS 9 CHARACTERS

L= 9 C(9)= 0.83333

CLUSTER MEMBERSHIP — C-VALUE — CONNECTEDNESS — R(9)
2 9 10 — 0.83333 — 2 3 — (9, 2)(
MOAT = 0.05556 NEXT PAIRS TO JOIN (9, 4) (

CLUSTER MEMBERSHIP — C-VALUE — CONNECTEDNESS — R(9)
3 6 7 12 13 — 0.87500 — 6 10
INTERNAL CONNECTIONS AT (0.83333) — INTERNAL CONNECTIONS AFTER (0.83333)
(12, 6) (

CLUSTER MEMBERSHIP — C-VALUE — CONNECTEDNESS — R(9)
15 16 17 18 19 20 21 — 0.87778 — 13 21
INTERNAL CONNECTIONS AT (0.83333) — INTERNAL CONNECTIONS AFTER (0.83333)
(21, 15) (— (18, 16) (19, 15) (20, 15) (21, 17) (18, 17)
(20, 17) (

SINGLE MEMBER CLUSTERS (9)
1, 4, 5, 8, 11, 14, 22, 23, 25,

SUCKERS R.J.BEHNKE 7 MAY 1967 25 OBJECTS 9 CHARACTERS

L= 10 C(10)= 0.80000

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS		R(10)
2 9 10	0.83333	2	3	
CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS		R(10)
3 6 7 12 13	0.87500	6	10	
CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS		R(10)
8 15 16 17 18 19 20 21	0.80000	14	28	(19, 8)(

MOAT = 0.03333 NEXT PAIRS TO JOIN (16, 11) (

SINGLE MEMBER CLUSTERS (8)
1, 4, 5, 11, 14, 22, 23, 25,

SUCKERS R.J.BEHNKE 7 MAY 1967 25 OBJECTS 9 CHARACTERS

L= 11 C(11)= 0.77778

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS	R(11)
2 4 9 10	0.77778	3 6	(9, 4)(

MOAT = 0.25556 NEXT PAIRS TO JOIN (25, 10) (

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS	R(11)
3 6 7 12 13	0.87500	6 10	

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS	R(11)
8 15 16 17 18 19 20 21	0.80000	14 28	

SINGLE MEMBER CLUSTERS (7)
1, 5, 11, 14, 22, 23, 25,

SUCKERS R.J.BEHNKE 7 MAY 1967 25 OBJECTS 9 CHARACTERS

L= 12 C(12)= 0.76667

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS	R(12)
1 8 11 15 16 17 18 19 20 21	0.76667	19 45	(11, 1)(16, 11)(

INTERNAL CONNECTIONS AT (0.76667)
(17, 16) (21, 19) (21, 18) (

INTERNAL CONNECTIONS AFTER (0.76667)

MOAT = 0.04444 NEXT PAIRS TO JOIN (18, 7) (

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS	R(12)
2 4 9 10	0.77778	3 6	

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS	R(12)
3 6 7 12 13	0.87500	7 10	

INTERNAL CONNECTIONS AT (0.76667)
(12, 3) (

INTERNAL CONNECTIONS AFTER (0.76667)

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS	R(12)
22 25	0.76667	1 1	(25, 22)(

MOAT = 0.03333 NEXT PAIRS TO JOIN (22, 14) (

SINGLE MEMBER CLUSTERS (3)
5, 14, 23,

SUCKERS R.J.BEHNKE 7 MAY 1967 25 OBJECTS 9 CHARACTERS

L= 9 C(9)= 0.83333

CLUSTER MEMBERSHIP — C-VALUE CONNECTEDNESS — R(9)
2 9 10 — 0.83333 2 3 — (9, 2)(
MOAT = 0.05556 NEXT PAIRS TO JOIN (9, 4) (

CLUSTER MEMBERSHIP — C-VALUE CONNECTEDNESS — R(9)
3 6 7 12 13 — 0.87500 6 10
INTERNAL CONNECTIONS AT (0.83333) — INTERNAL CONNECTIONS AFTER (0.83333)
(12, 6) (

CLUSTER MEMBERSHIP — C-VALUE CONNECTEDNESS — R(9)
15 16 17 18 19 20 21 — 0.87778 13 21
INTERNAL CONNECTIONS AT (0.83333) — INTERNAL CONNECTIONS AFTER (0.83333)
(21, 15) (— (18, 16) (19, 15) (20, 15) (21, 17) (18, 17)
(20, 17) (

SINGLE MEMBER CLUSTERS (9)
1, 4, 5, 8, 11, 14, 22, 23, 25,

SUCKERS R.J.BEHNKE 7 MAY 1967 25 OBJECTS 9 CHARACTERS

L= 10 C(10)= 0.80000

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS		R(10)
2 9 10	0.83333	2	3	
CLUSTER MEMBERSHIP	**C-VALUE**	**CONNECTEDNESS**		**R(10)**
3 6 7 12 13	0.87500	6	10	
CLUSTER MEMBERSHIP	**C-VALUE**	**CONNECTEDNESS**		**R(10)**
8 15 16 17 18 19 20 21	0.80000	14	28	(19, 8)(

MOAT = 0.03333 NEXT PAIRS TO JOIN (16, 11) (

SINGLE MEMBER CLUSTERS (8)
1, 4, 5, 11, 14, 22, 23, 25,

SUCKERS R.J.BEHNKE 7 MAY 1967 25 OBJECTS 9 CHARACTERS

L= 11 C(11)= 0.77778

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS	R(11)
2 4 9 10	0.77778	3 6	(9, 4)(

MOAT = 0.25556 NEXT PAIRS TO JOIN (25, 10) (

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS	R(11)
3 6 7 12 13	0.87500	6 10	

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS	R(11)
8 15 16 17 18 19 20 21	0.80000	14 28	

SINGLE MEMBER CLUSTERS (7)
1, 5, 11, 14, 22, 23, 25,

SUCKERS R.J.BEHNKE 7 MAY 1967 25 OBJECTS 9 CHARACTERS

L= 12 C(12)= 0.76667

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS	R(12)
1 8 11 15 16 17 18 19 20 21	0.76667	19 45	(11, 1)(16, 11)(

INTERNAL CONNECTIONS AT (0.76667)
(17, 16) (21, 19) (21, 18) (

INTERNAL CONNECTIONS AFTER (0.76667)

MOAT = 0.04444 NEXT PAIRS TO JOIN (18, 7) (

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS	R(12)
2 4 9 10	0.77778	3 6	

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS	R(12)
3 6 7 12 13	0.87500	7 10	

INTERNAL CONNECTIONS AT (0.76667)
(12, 3) (

INTERNAL CONNECTIONS AFTER (0.76667)

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS	R(12)
22 25	0.76667	1 1	(25, 22)(

MOAT = 0.03333 NEXT PAIRS TO JOIN (22, 14) (

SINGLE MEMBER CLUSTERS (3)
5, 14, 23,

SUCKERS R.J.BEHNKE - 7 MAY 1967 25 OBJECTS 9 CHARACTERS

L= 13 C(13)= 0.75556

CLUSTER MEMBERSHIP C-VALUE CONNECTEDNESS R(13)
1 8 11 15 16 17 18 19 20 21 0.76667 23 45
INTERNAL CONNECTIONS AT (0.75556)
(15, 8) (19, 18) (20, 19) (
INTERNAL CONNECTIONS AFTER (0.75556)
(17, 8) (

CLUSTER MEMBERSHIP C-VALUE CONNECTEDNESS R(13)
2 4 9 10 0.77778 4 6
INTERNAL CONNECTIONS AT (0.75556)
(10, 4) (
INTERNAL CONNECTIONS AFTER (0.75556)

CLUSTER MEMBERSHIP C-VALUE CONNECTEDNESS R(13)
3 6 7 12 13 14 0.75556 10 15 (14, 7)(
INTERNAL CONNECTIONS AT (0.75556)
(7, 6) (
INTERNAL CONNECTIONS AFTER (0.75556)
(6, 3) (

MOAT = 0.02222 NEXT PAIRS TO JOIN (22, 14) (

CLUSTER MEMBERSHIP C-VALUE CONNECTEDNESS R(13)
22 25 0.76667 1 1

SINGLE MEMBER CLUSTERS (2)
5, 23,

SUCKERS R.J.BEHNKE 7 MAY 1967 25 OBJECTS 9 CHARACTERS

L= 14 C(14)= 0.73333

CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS	R(14)
1 8 11 15 16 17 18 19 20 21	0.76667	23 45	
CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS	R(14)
2 4 9 10	0.77778	4 6	
CLUSTER MEMBERSHIP	C-VALUE	CONNECTEDNESS	R(14)
3 6 7 12 13 14 22 25	0.73333	12 28	(22, 14)(

MOAT = 0.01111 NEXT PAIRS TO JOIN (18, 7) (25, 5) (

SINGLE MEMBER CLUSTERS (2)
5, 23,

SUCKERS R.J.BEHNKE 7 MAY 1967 25 OBJECTS 9 CHARACTERS

L= 15 C(15)= 0.72222

CLUSTER MEMBERSHIP C-VALUE CONNECTEDNESS R(15)
1 3 5 6 7 8 11 12 13 14 0.72222 37 171 (18, 7)(25, 5)(
15 16 17 18 19 20 21 22 25
MOAT = 0.01111 NEXT PAIRS TO JOIN (23, 20) (

CLUSTER MEMBERSHIP C-VALUE CONNECTEDNESS R(15)
2 4 9 10 0.77778 5 6
INTERNAL CONNECTIONS AT (0.72222) INTERNAL CONNECTIONS AFTER (0.72222)
(4, 2) (

SINGLE MEMBER CLUSTERS (1)
23,

SUCKERS R.J.BEHNKE 7 MAY 1967 25 OBJECTS 9 CHARACTERS

L= 16 C(16)= 0.71111

CLUSTER MEMBERSHIP C-VALUE CONNECTEDNESS R(16)
1 3 5 6 7 8 11 12 13 14 0.71111 115 190 (23, 20)(
15 16 17 18 19 20 21 22 23 25
INTERNAL CONNECTIONS AT (0.71111)
(11, 5) (25, 20) (18, 8) (14, 12) (21, 11)
(20, 16) (19, 16) (14, 6) (

INTERNAL CONNECTIONS AFTER (0.71111)
(5, 1) (21, 8) (7, 3) (22, 7) (22, 12)
(22, 6) (25, 15) (23, 8) (11, 8) (15, 7)
(21, 20) (25, 7) (25, 12) (23, 22) (18, 12)
(15, 11) (23, 11) (25, 17) (22, 13) (16, 1)
(16, 8) (25, 23) (23, 15) (23, 17) (16, 5)
(20, 12) (22, 20) (25, 14) (25, 6) (20, 7)
(14, 13) (25, 19) (20, 8) (25, 18) (18, 1)
(23, 18) (15, 12) (18, 6) (18, 11) (19, 11)
(23, 5) (21, 1) (19, 7) (23, 19) (18, 14)
(20, 14) (25, 13) (21, 5) (22, 3) (25, 16)
(23, 1) (7, 1) (16, 7) (20, 6) (20, 5)
(19, 12) (15, 6) (22, 15) (19, 5) (17, 14)
(8, 7) (18, 13) (11, 7) (15, 1) (22, 17)
(25, 1) (17, 11) (23, 16) (17, 7) (

MOAT = 0.18889 NEXT PAIRS TO JOIN (25, 10) (

CLUSTER MEMBERSHIP C-VALUE CONNECTEDNESS R(16)
2 4 9 10 0.77778 6 6
INTERNAL CONNECTIONS AT (0.71111)

INTERNAL CONNECTIONS AFTER (0.71111)
(10, 2) (

SINGLE MEMBER CLUSTERS (0)

SUCKERS R.J.BEHNKE 7 MAY 1967 25 OBJECTS 9 CHARACTERS

L= 17 C(17)= 0.52222

CLUSTER MEMBERSHIP										C-VALUE	CONNECTEDNESS		R(17)
1	2	3	4	5	6	7	8	9	10	0.52222	122	276	(25, 10)(
11	12	13	14	15	16	17	18	19	20				
21	22	23	25										

SINGLE MEMBER CLUSTERS (0)

SUCKERS R.J.BEHNKE 7 MAY 1967 25 OBJECTS 9 CHARACTERS

NODAL DISTANCE ARRAYS

I	J	S(I,J)	J	S(I,J)	J	S(I,J)	J	S(I,J)	J	S(I,J)
1	11	0.76667	5	0.70000	16	0.64444	18	0.60000	21	0.58889
	23	0.55556	7	0.54444	15	0.53333	25	0.53333	20	0.48889
2	9	0.83333	4	0.72222	10	0.70000	5	0.38889	3	0.35556
	25	0.35556	1	0.31111	22	0.28889	11	0.27778	21	0.27778
3	13	0.93750	12	0.76667	6	0.74444	7	0.70000	22	0.55556
	14	0.51111	16	0.51111	5	0.50000	1	0.48889	11	0.47778
4	9	0.77778	10	0.75556	2	0.72222	25	0.40000	12	0.37778
	22	0.35556	8	0.34444	6	0.33333	7	0.31111	3	0.30000
5	25	0.72222	11	0.71111	1	0.70000	16	0.61111	23	0.58889
	21	0.55556	20	0.54444	19	0.54444	22	0.51111	3	0.50000
6	13	0.87500	12	0.82222	7	0.75556	3	0.74444	14	0.71111
	22	0.66667	25	0.61111	18	0.58889	20	0.54444	15	0.54444
7	12	0.93333	13	0.85000	6	0.75556	14	0.75556	18	0.72222
	3	0.70000	22	0.68889	15	0.65556	25	0.65556	20	0.61111
8	19	0.80000	15	0.75556	17	0.74444	18	0.71111	21	0.70000
	23	0.66667	11	0.65556	16	0.64444	20	0.60000	7	0.54444
9	10	0.86667	2	0.83333	4	0.77778	25	0.50000	8	0.43333
	22	0.43333	19	0.43333	17	0.40000	7	0.37778	23	0.34444
10	9	0.86667	4	0.75556	2	0.70000	25	0.52222	7	0.48889
	8	0.43333	19	0.43333	12	0.42222	15	0.41111	17	0.40000
11	1	0.76667	16	0.76667	5	0.71111	21	0.71111	8	0.65556
	15	0.65556	23	0.65556	18	0.58889	19	0.58889	7	0.53333
12	7	0.93333	13	0.92500	6	0.82222	3	0.76667	14	0.71111
	22	0.68889	25	0.65556	18	0.65556	20	0.61111	15	0.58889
13	3	0.93750	12	0.92500	6	0.87500	7	0.85000	22	0.65000
	14	0.60000	25	0.56250	18	0.53750	5	0.50000	15	0.48750
14	7	0.75556	22	0.73333	12	0.71111	6	0.71111	25	0.61111
	13	0.60000	18	0.56667	20	0.56667	17	0.54444	3	0.51111
15	18	0.93333	16	0.88889	17	0.87778	21	0.83333	19	0.82222
	20	0.82222	8	0.75556	25	0.66667	7	0.65556	11	0.65556
16	21	0.94444	15	0.88889	18	0.82222	17	0.76667	11	0.76667
	20	0.71111	19	0.71111	1	0.64444	8	0.64444	5	0.61111
17	19	0.94444	15	0.87778	21	0.82222	18	0.81111	20	0.81111
	16	0.76667	8	0.74444	25	0.65556	23	0.63333	14	0.54444
18	15	0.93333	20	0.88889	16	0.82222	17	0.81111	21	0.76667
	19	0.75556	7	0.72222	8	0.71111	12	0.65556	25	0.60000

SUCKERS R.J.BEHNKE 7 MAY 1967 25 OBJECTS 9 CHARACTERS

NODAL DISTANCE ARRAYS

I	J	S(I,J)	J	S(I,J)	J	S(I,J)	J	S(I,J)	J	S(I,J)
19	17	0.94444	15	0.82222	8	0.80000	21	0.76667	18	0.75556
	20	0.75556	16	0.71111	25	0.60000	11	0.58889	7	0.58889
20	18	0.88889	15	0.82222	17	0.81111	19	0.75556	25	0.71111
	16	0.71111	23	0.71111	21	0.65556	12	0.61111	22	0.61111
21	16	0.94444	15	0.83333	17	0.82222	19	0.76667	18	0.76667
	11	0.71111	8	0.70000	20	0.65556	1	0.58889	5	0.55556
22	25	0.76667	14	0.73333	7	0.68889	12	0.68889	6	0.66667
	23	0.65556	13	0.65000	20	0.61111	3	0.55556	15	0.54444
23	20	0.71111	8	0.66667	22	0.65556	11	0.65556	25	0.64444
	15	0.64444	17	0.63333	18	0.60000	5	0.58889	19	0.57778
25	22	0.76667	5	0.72222	20	0.71111	15	0.66667	7	0.65556
	12	0.65556	17	0.65556	23	0.64444	14	0.61111	6	0.61111

BEHNKE

UNCOMPAHGRE COLLECTION 18 MARCH

AA-425

COMPARISON OF CHARACTERS

ACOUSTIC CHARS	N=10 C. discoidea	N=8 C. cotyledonis	N=7 C. comptoniae
PAV CHARS			
D	$\bar{X}$ = 10.5 R = 9-12 σ = ± .849	$\bar{X}$ = 12.00 R = 11-13 σ = ± .816	$\bar{X}$ = 10.572 R = 9-12 σ = ± .976
C	$\bar{X}$ = 19.00 R = 18-20 σ = ± .666	$\bar{X}$ = 18.75 R = 18-19 σ = ± .901	$\bar{X}$ = 18.714 R = 18-19 σ = ± .488
A	$\bar{X}$ = 7.6 R = 6-9 σ = ± .343	$\bar{X}$ = 7.00 R = 7-7 σ = ± 0	$\bar{X}$ = 7.57 R = 7-8 σ = ± .535
P_3	$\bar{X}$ = 8.8 R = 8-9 σ = ± .1.75	$\bar{X}$ = ~~15.25~~ 9.00 R = ~~15-16~~ 9-9 σ = ~~± .901~~ ± 0	$\bar{X}$ = 10.43 R = 9-11 σ = ± .7869
P_1	$\bar{X}$ = 14.9 R = 14-15 σ = ± .516	$\bar{X}$ = 15.25 R = 15-16 σ = ± .901	$\bar{X}$ = 15.429 R = 15-17 σ = ± .7869

σ = 1 STANDARD DEVIATION

MERISTIC (cont.) CHAR	N=10 C. DISCOBOLUS	N=8 C. LATIPINNIS	N=7 C. COMMERSONII
SCALE COUNTS			
LL	$\bar{X}$ = 108.7 R = 104-120 σ = ± 4.877	$\bar{X}$ = 112.00 R = 107-120 σ = ± 4.00	$\bar{X}$ = 66.86 R = 65-72 σ = ± 2.873
ALL	$\bar{X}$ = 19.1 R = 17-21 σ = ± 1.100	$\bar{X}$ = 23.00 R = 20-20 σ = ± 2.138	$\bar{X}$ = 11.00 R = 11-11 σ = ± 0
BLL	$\bar{X}$ = 19.1 R = 17-26 σ = ± 3.071		$\bar{X}$ = 10.57 R = 9-14 σ = ± 1.618
ACP	$\bar{X}$ = 10.2 R = 9-11 σ = ± .789	$\bar{X}$ = 11.625 R = 10-14 σ = ± .3756	$\bar{X}$ = 9.286 R = 9-10 σ = ± .488
GILL RAKER	$\bar{X}$ = 43.2 R = 40-48 σ = ± 3.033	$\bar{X}$ = 26.125 R = 25-27 σ = ± .870	$\bar{X}$ = 23.71 R = 22-24 σ = ± .756
RATIOS			
HL/HW	$\bar{X}$ = 1.252 R = 1.194-1.345 σ = ± .0435	$\bar{X}$ = 1.501 R = 1.467-1.557 σ = ± .0398	$\bar{X}$ = 1.487 R = 1.38-1.65 σ = ± .0871
SNL/PHL	$\bar{X}$ = 1.427 R = 1.105-1.611 σ = ± .145	$\bar{X}$ = 1.171 R = 1.046-1.269 σ = ± .208	$\bar{X}$ = 1.056 R = .955-1.130 σ = ± .0567

Ratios (cont)	C. discobolus N=10	C. lampinurus N=8	C. commersoni N=7
BD/LOCP	$\bar{X}$ = 2.739 R = 2.633-2.909 σ = ± .1311	$\bar{X}$ = 2.795 R = 2.667-3.000 σ = ± .112	$\bar{X}$ = 2.283 R = 2.130-2.38 σ = ± .0844
SNL/HL	$\bar{X}$ = .503 R = .500-.554 σ = ± .0184	$\bar{X}$ = .490 R = .458-.508 σ = ± .0197	$\bar{X}$ = .440 R = .419-.458 σ = ± .0129
HW/IOW	$\bar{X}$ = 1.623 R = 1.429-1.714 σ = ± .1227	$\bar{X}$ = 1.526 R = 1.442-1.636 σ = ± .069	$\bar{X}$ = 1.452 R = 1.379-1.545 σ = ± .0544

ABBREVIATIONS

D = PRINCIPAL RAYS IN DORSAL FIN
C = " " " CAUDAL "
A = " " " ANAL "
P_1 = " " " PECTORAL "
P_2 = " " " PELVIC "

LL = NO OF SCALES IN LATERAL LINE
ALL = " " " ABOVE " "
BLL = " " " BELOW " "
ACP = " " " ALONG SIDES OF CAUDAL PEDUNCLE

HL = HEAD LENGTH; HW = HEAD WIDTH
SNL = SNOUT LENGTH BD = GREATEST BODY DEPTH
LOCP = LEAST DEPTH CAUDAL PEDUNCLE
IOW = INTER ORBITAL WIDTH

Data on Uncompagre collection no. 2., north of Montrose, 2 miles

CWAR,	N=11 DISCOBOLUS (? HYBRID) ?	N=11 DISCOBOLUS	N=8 LATIPINNIS	N=1 COMMERSONI
PRIN. FIN RAYS				
D	$\bar{X}$ = 11.727 ±.806 R = 11-13	$\bar{X}$ = 11.36 ±.674 R = 11-13	$\bar{X}$ = 12.0 ±0 R = ~~12-13~~ 12-13	12.0
C	$\bar{X}$ = 18.273 ±.647 R = 18-20	$\bar{X}$ = 18.27 ±.786 R = 17-20	$\bar{X}$ = 18.0 ±0 R = 18-19	18.0
A	$\bar{X}$ = 8 ±0 R = 8-8	$\bar{X}$ = 8 ±.542 R = 8-8	$\bar{X}$ = 8 ±.577 R = 7-9	8.0
P_2	$\bar{X}$ = 9 ±0 R = 9-9	$\bar{X}$ = 9 ±.316 R = 9-9	$\bar{X}$ = 9.57 ±.535 R = 9-10	10.0
P_1	$\bar{X}$ = 14.00 ±.894 R = 13-16	$\bar{X}$ = 13.91 ±1.513 R = 10-15	$\bar{X}$ = 16.29 ±1.38 R = 15-18	15.0
SCALES				
LL	X = 106.00 ±6.69 R = 93-116	X = 112.182 R = 105-122 ±5.231	$\bar{X}$ = 111.86 ±4.94 R = 105-118	66
ALL	X = 19.82 ±1.94 R = 18-24	X = 21.45 ±.934 R = 21-23	X = 24.57 ±1.62 R = 22-27	13
BLL	X = 20.82 ±2.32 R = 18-25	X = 22.91 ±1.92 R = 18-24	X = 25.143 ±2.50 R = 24-30	13
ACP	X = 10.82 ±.95 R = 10-12	X = 1964 ±.92 R = 10-12	X = 10.714 ±.95 R = 10-12	10
GILL RAKERS	* TO BE TAKEN LATER			

CHAR	N=11 DISCOBOLUS (HYBRID)	N=11 DISCOBOLUS	N=8 LATIPINNIS	N=1 COMMERSONI
TL/HL	$\bar{X}$ = ~~5.882~~ 5.936 R = 5.619 – 6.289 ± .528	$\bar{X}$ = ~~6.277~~ 6.013 R = 5.819 – 6.400 ± .246	$\bar{X}$ = 5.2498 R = 5.047 – 5.377 ± .115	5.196
HL/HW	$\bar{X}$ = 1.260 R = 1.152 – 1.323 ± .06	$\bar{X}$ = ~~1.277~~ ± .07 $\bar{X}$ = 1.287 R = 1.178 – 1.422	$\bar{X}$ = 1.581 R = 1.992 – 1.767 ± .107	1.533
SnL/PhL	$\bar{X}$ = 1.525 R = 1.211 – 1.782 ± .27	$\bar{X}$ = 1.577 R = 1.357 – 1.727 ± .15	$\bar{X}$ = 1.249 R = 1.095 – 1.292 ± .119	1.111
BD/LDCP	$\bar{X}$ = 2.688 R = 2.312 – 3.000 ± .265	$\bar{X}$ = 2.758 R = 2.533 – 2.938 ± .178	$\bar{X}$ = 2.850 R = 2.688 – 3.214 ± .191	2.222
SnL/HL	$\bar{X}$ = .5377 R = .5135 – .5610 ± .024	$\bar{X}$ = .525 R = .486 – .575 ± .027	$\bar{X}$ = .507 R = .460 – .533 ± .026	.4348

		LATIPINNIS		DISCOBOLUS			COMMERSONI	
		D=8	D=7	D=10	D=11	D=11 (?)	D=7	D=1
RAY	D	12	12	10.5	11.36	11.72	10.57	12
	C	18.75	18.0	19.0	18.27	18.27	18.74	18
	A	7.0	8.0	7.6	8	8	7.57	8
	P_2	9.0	9.57	8.8	9	9	10.43	10
	P_1	15.25	16.29	14.4	13.91	14.0	15.43	15
SCALES	LL	112.0	111.86	108.7	112.18	106.0	66.86	66
	ALL	23.0	24.57	19.1	21.45	19.82	11.00	13
	BLL		25.14	19.1	22.91	20.82	10.57	13
	ACP	11.63	10.71	10.2	1064	10.82	9.28	10
RATIOS	HL/HD	1.501	1.5814	1.252	1.287	1.260	1.487	1.533
	SnL/PHL	1.171	1.249	1.427	1.577	1.525	1.055	1.111
	HL/IOW	1.526		1.623			1.452	
	BD/LOWP	2.795	2.850	2.739	2.758	2.688	2.283	2.222
	SnL/HL	.480	.507	.523	.525	.5377	.440	.435
	TL/HL	5.182	5.250	5.891	6.013	5.482	5.252	5.196
RAKERS		26.125		43.2			22.71	

COMPARISON OF TWO UNCOMPARED COLLECTIONS

NUMBERS GIVEN ARE MEANS

Characters used in study of suckers of Gunnison R., by R. J. BEHNKE

K1: No. scales in lateral line

to 72	73 – 90	91 →
1	2	3

3 states simple

K2: No. scales above lateral line.

to 16	17 – 20	21 →
1	2	3

3 states simple

K3: No. Dorsal fin rays

10	11	12	13
1	2	3	4

– 4 states ordered N1 K4

K4: No. Pectoral fin rays

13	14	15	16	17
1	2	3	4	5

– 5 states ordered N2 K5

K5: No. Pelvic fin rays

8	9	10	11	12
1	2	3	4	5

– 5 states ordered N2 K5

K6: No. Gillrakers

to 25	26 – 29	30 →
1	2	3

– 3 states Matrix

	1	2	3
1	.9		
2	.4	.9	1
3	0	0	1

K7: Lateral notch present in lips – 1 2 states
" absent " " – 2 Simple
Count this character twice

K8: No. vertebrae

41-42	43-44
1	2

– 2 states simple

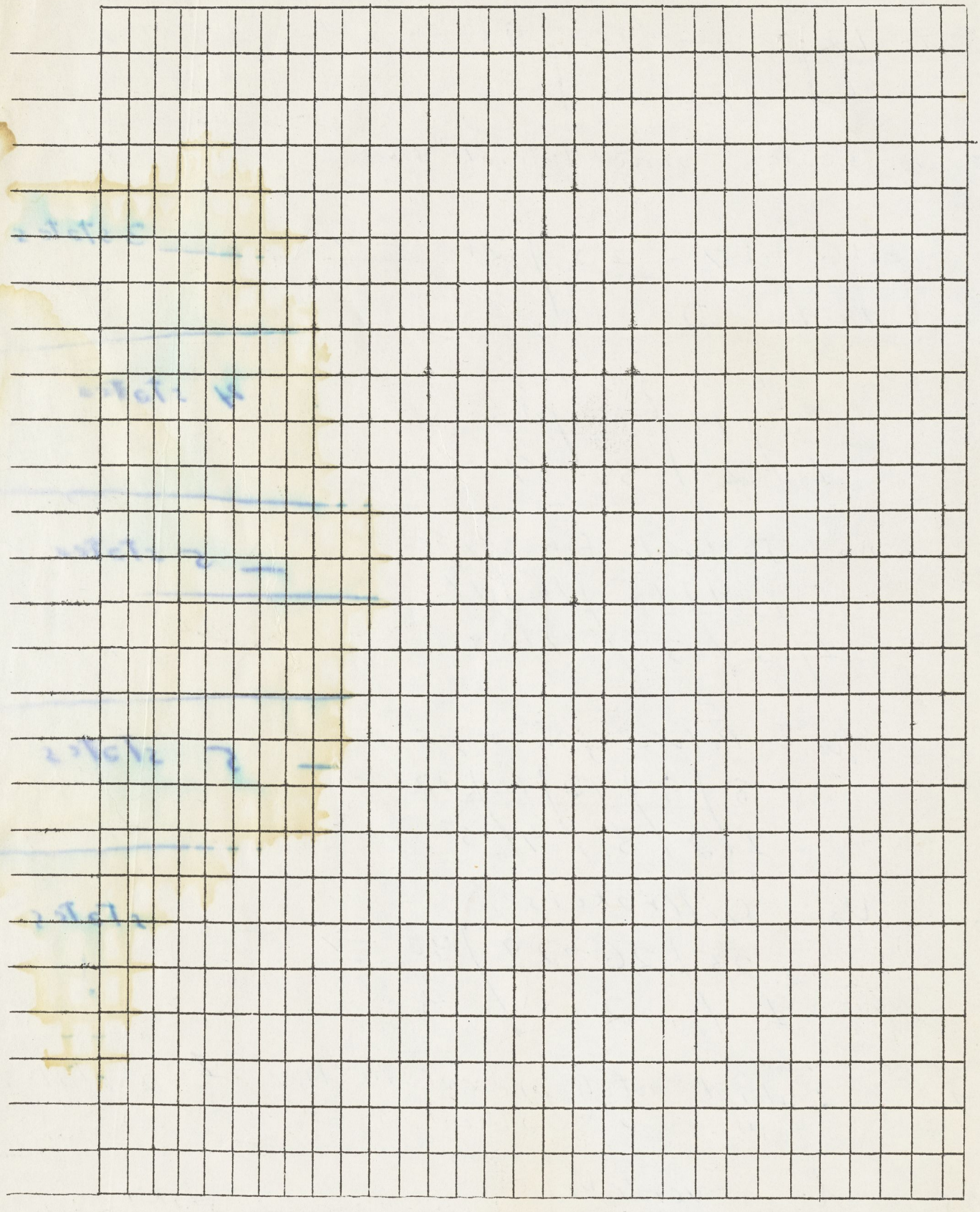
ordered

K9: Relative length of dorsal fin: → | 1 29 | 2 130-145 | 3 146-160 | 4 161 → 4 states nL K4

CODING FORM

Objects

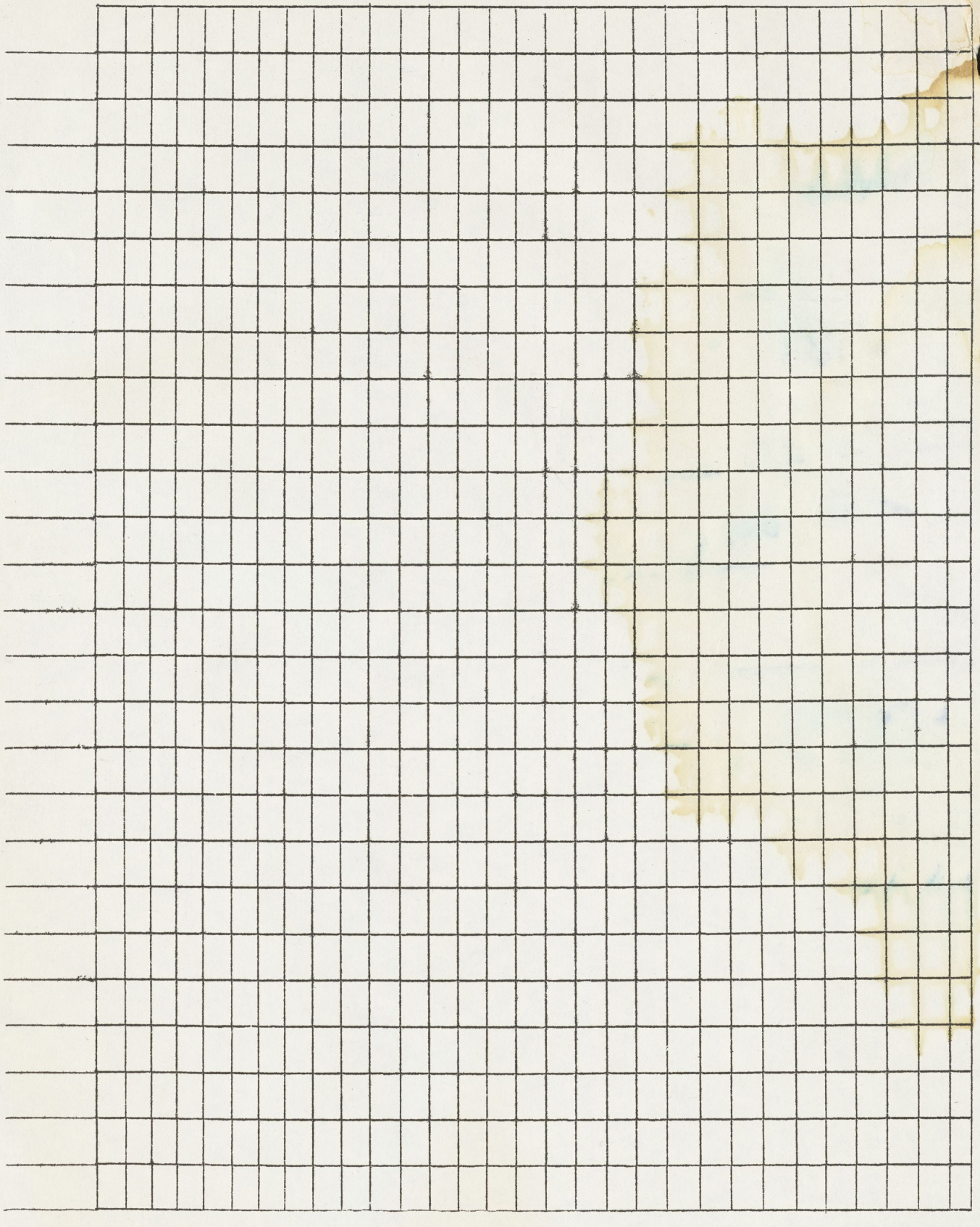
Characters and Character states



CODING FORM

Objects

Characters and Character states



SUCKERS R.J.BEHNKE 7 MAY 1967 25 OBJECTS 9 CHARACTERS

0 0 0 0 0 0 0 4 1 0 5 2 0 5 2 3 0 0 0 0 0 0 0 0 0 4 99

-400 000 00099999 ok

223432213 1
321213112 2
334231214 3
321113124 4
222331211 5
334441224 6
333331223 7
111322223 8
321223122 9
322223123 10
212332213 11
333331224 12
334331204 13
333551222 14
112431223 15
112431213 16
112421222 17
113431223 18
112321222 19
113431221 20
112421213 21
331531221 22
211432221 23
112431223 24
322431221 25
99999