TROG

THE

TECH

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VOL XVII
FALL 1978

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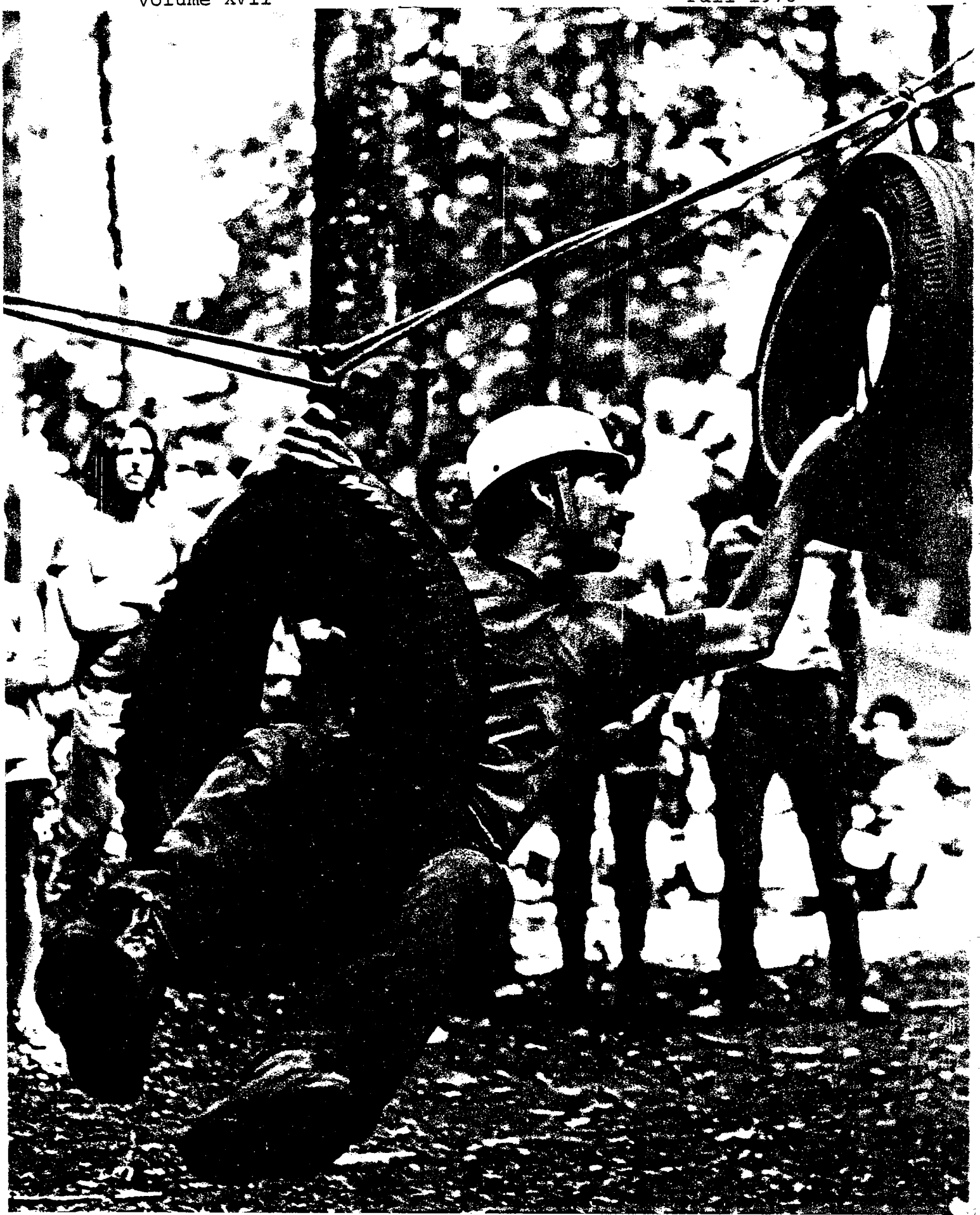

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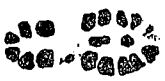


PRESIDENT'S COLUMN

Last Spring when I was elected to this glorious office, I decided it was about time to do something about the low membership this Grotto is suffering from. In the four years previous that I had been associated with the Grotto, I had seen only 19 regular and associate members voted in. Now, many of these people are no longer living in the area or active caving.

With 20,000 students enrolled here it seemed obvious that we had been doing something wrong not to have a much larger group. Of course, the Grotto had always been very active with a lot of hard core caving, especially mapping, going on. However, as a student grtto, it is crucial to get a steady supply of new members to take over for people as they graduate or otherwise leave.

Together with Vice-president Chuck Shorten I decided to establish a goal of voting in at least ten new members during the 78-79 school year, and reducing or eleminating the feeling of apathy which seemed to be entering grotto affairs.

Those of you unfamiliar with the VPI Grotto or who have simply forgotten may find it incredible that a club could exist with so few members; therefore, let me explain. Anywhere from 40 to 75 people will show up at our weekly meetings. However, in order to become a member a person must complete a comprehensive membership program aimed at assuring a certain amount of practical caving knowledge. This program requires a little time to complete but is actually easy for anyone willing to go on a few caving trips. Unfortionatly, in the past too few people have passed or been actively encouraged to pass these membership requirements and get voted into the Grotto, and the grotto membership has declined as a result.

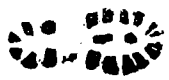
Now that one school quarter is up it appears that our membership goal of ten new members this year should easily be exceeded sometime during Winter quarter. Five have been voted in Fall quarter. This exceeds the yearly average for the past four years. It is especially important that membership be high this year, because three of us who are club officers as well as several other of the club's more active members are supposed to graduate and presumably leave at the end of this year. Things are looking great so far but only time will tell for sure.

Well, enough for patting ourselves on the back. Last June several of us came up with a neat idea that the Grotto should definately consider and discuss. How about a Grotto fieldhouse somewhre in Giles or Bland county? Now that the club is wealthy from winning all those Miller Brewing Company contest we could probably afford to rent an old, possibly run

down house somewhere near the area in which we cave. This would provide an excellent place for weary cavers to stay instead of driving fifty miles back from caving in Skydusky Hollow at 2:30 in the morning. It would be a place where cavers could gather to enjoy (?) company of other cavers. We would always have a great party place for Banquet, Float Trip, or Halloween Party. It would prove an exciting way for students stuck in the dorms to escape for the weekend. It could be an excellant liason between VPI Grotto and other VAR cavers as they would have a place to stay in this caving area they could use.The success other grottos have had with field houses inspires this idea. We might even be able to charge a slight fee for using the place and possiblv make a profit. It would undoutedly interest many of the VPI Grotto alumni into becoming active again. anyway, it should be a good topic of discussion at the Hokie House after the Friday meeting over a pitcher of beer.

Well, I had a few other things which I was going to say, but this column is getting too long anyway so Editor Bob Alderson woul probably cut them out. Besides, that will leave something for the winter Trog. Good Caving!

Ed Devine



Banquet is on February 17.

EDITOR'S COLUMN

I want to thank everybody who helped with the Trog this fall. Pat Louden's work on the Grotto Grapevine was invaluable. Laura Alderson shared the typing load and offered editorial advice. Joe Zokaites handled the exchange subscriptions this year. The cover drawing is by Boo. Special thanks to Ed Devine for posing for the photo.

Several people have mentioned to me that they are working on articles for the next issue. I am looking forward to seeing them. With all the Grotto's activity, I hope to see more articles submitted. Considering the range of interests encompassed by caving, and the diversity of people, a great variety of material should be available. Anything that reflects an interest in caving or the club is suitable.

Trip reports, letters to the editor, flag-waving, editorials, fantasy, fiction, cartoons, essays, technical articles and speleological articles are needed for the next issue. Anything from a one-paragraph synopsis of a project or caving trip to a complete article is acceptable. I would also like to mention that there are many openings available on the Troglodyte staff.

-- Bob Alderson

Grotto Grapevine

by
Pat Louden

Within the last nine months, so much has happened that it is difficult to write it all down so here are the highlights:

Picnic weekend began cold and gray. It ended cold and gray. Float trip went well with perfect weather and a new course down the New River from Pearisburg to Richcreek. There were the usual minor mishaps that accompany all float trips -- not enough beer, the loss of some rafts and canoes at a small, but exciting, set of rapids, and some isolated cases of sunburn. Compliments go to Admiral Jerry Redder for a float trip well done.

Float trip party also had its memorable moments. The Christiansburg house will never be the same. Between Chuck Shorten's violent attack on the screen door and several others' taking out their frustrations on a wall, it is a wonder the place is still standing.

Old Timers' Reunion was exciting, with the only problem being a slight shortage of wine (met with wild cries of "More wine!"). VPI cavers and alumni won most of the awards (again): Dennis Vaders took first place overall and won a huge sleeping bag; Ed Devine came in second and received a tent; Chuck Shorten was third and won a Wheat lamp. Among the alumni who won: Janet Queisser and Annie Whittemore. Current member Joe Zokaites also was a winner. (Cheryl Jones and Annie Whittemore are running next year's Old Timers'.)

Mike Frame's hometown of Birch River, West Virginia, was the site of a four-wheel drive rally this summer. Carl Hamm, Chuck Shorten, Jim Denton, Jock and Carol Bearden, Randy and Cathy Wood and Suzanne and Mike Rame brought their vehicles for a weekend of fun in the mud.

Fall began with John Deck celebrating his 25th birthday at the Hokie House by buying several rounds of beer for everyone. Two weeks later, Mike Richardson celebrated his 25th. Ed Devine and Chuck Shorten had a keg party two weeks later for their 22nd birthdays. That's a lot of birthdays and beer!

Halloween party (two weeks later) was a great success. The Main Street house was the perfect place and there were several outstanding costumes. Eccentric Stringfellow decided against his usual lady-of-the-night attire and came instead as a computer card. He was promptly folded, spindled and mutilated. Jan Roode arrived as a bionic chicken and Danny Wright was a Cylon warrior.

The weekend after Halloween, Danny Wright had his first annual over-the-hill party. Yes, ladies and gents, the over-the-hill gang drank again and again and again. If you don't believe it, ask Ned Coleman!

The club had several weddings: Jock and Carol tied the knot with a cigar band instead of a ring; Phil Sica married his true love, Karen; and Buckwheat made an honest woman out of Nancy. Nancy had him in ball and chain immediately following the ceremony. Mike Richardson displayed exceptional skill and willingness by retrieving both garters at Buckwheat's and Jock's weddings.

Meanwhile, below ground . . .

Bill Koerschner has over four miles mapped in Spring Hollow.

After mapping a mile in Paul Penley's, Ed Devine promises "big discoveries."

Harman's Avalanche Pit was mapped to 1,200 feet long and 200 feet deep by Ed.

Bob Alderson has mapped 1,279 feet in Matachock, going down 337 feet.

Pete Sauvigne and Bob have mapped 10,363 feet in Kimballton Mine Cave (also known as Virginia Lime).

Rolf McQueary has finally finished Salamander, with about 4.2 miles of passage.

Nancy Hamm had another Hammster, Brian, in October, 1978.

Dale and Cathy Parrot have a bambino, Jason, born in April, 1978.

Last summer, Jackie and Jerry Redder, Ed Devine, Chuck Shorten, Joe Zokaites, Tom Calhoun and Suzanne and Mike Frame went to Wyoming to try their luck in the Grand Tetons.

Among those going to Convention were Jock and Carol, Donny Carter, Jim Denton, Ed Loud, Alan Armstrong, Doug Perkins and others. All would rather died than live in Texas.

Bill Stringfellow, Mark Powers and Jerry Redder went to Oklahoma City, which is the best place, allegedly, to see a meteor shower. How they ended up visiting Skip and Francis Whitehurst in Houston, Texas, is a mystery.

This fall, a certain crew of stalwart souls did an 830-feet climb and rappel in a neighboring state . . .

Vertical session was at Maybrook Sinkhole this fall, with a good turnout of prospective members. Special thanks to everyone who helped Chuck make it a success.

It looks as if the club will exceed its goal of 10 new members this year. Already, fall quarter there have been five new members: Bill Stephens (204); Wynn Wright (205); Eric Harper (206); John Dec (207); and Dave Shantz (208). Welcome!

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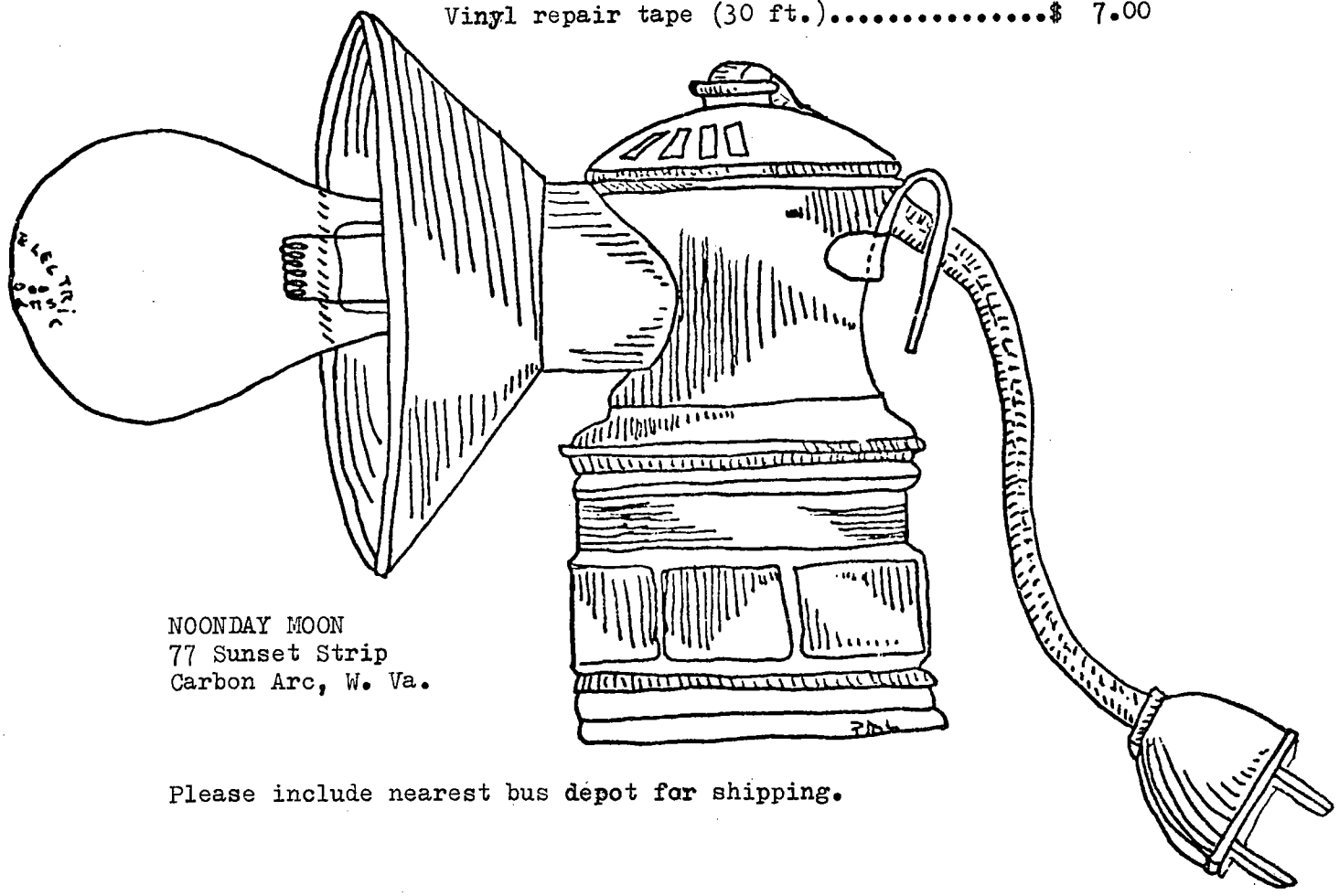

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The Opening of Spring Hollow

by Pam Wolf

Friday, Oct. 31, 1976, at the VPI Cave Club meeting, Chuck Shorten asked who'd be interested in digging out what he thought was a cave over in Bland County. Dennis Vaders and I, a trainee, decided we were going to go into this cave if it were the last thing we did. Besides, I wanted to go caving, Chuck needed a car, and Dennis was dumb enough to go along to drive.

The morning began at 8 a.m., when we were to meet Chuck in Owens for breakfast. After a slight delay -- to get my ID card from Dennis's room -- we ate a nice breakfast (at the dining hall?) and went to gather gear.

Gathering gear took about an hour and a half. When we left Blacksburg, we had enough sling for an army, plus shovels and anything else we could think of. Next, we went to sign out at the Loud's. Finally, after neatly weaving miles of sling, we were on our way.

We stopped at Don Anderson's in Dublin to get more sling. Don told us how sick he had gotten the night before. He told us he had a pick we could use. On to the cave! We drove toward Buddy Penley's, stopping for bread, bologna and a can of Hawaiian Punch.

We pulled up at a big white house in front of the power line cut near where Chuck had found the hole last spring. We were met at the door by Mrs. Banes. Would she mind if we looked for a cave on the property? She said we must want Buddy Penley down the road. Chuck explained he'd found the hole while walking down the cut last spring. Mrs. Banes talked to her husband, who seemed unsure about these young speleologists, but who gave permission.

Off we went, through the field, carefully avoiding cattle with big horns and cow pies. We located the big rock near the hole. We spent 15 or 20 minutes throwing rocks down it. Then we began to dig.

Finally, we cleared enough rocks to get in, or so we thought. We hurried back to the car for gear and to the Baneses for permission to enter the cave. When we told her the location, she said they called the area Spring Hollow. We got permission to drive to the entrance.

We were ready to go caving. Chuck tried to rig a cam rig while Dennis tied off to a tree. The entrance appeared to be a 30-feet drop and Chuck wanted to go first. Down he went, until he got to a narrow part and tried to squeeze through. "I'm stuck!" he yelled.

Dennis and I pulled him up (he was only three feet down) and we decided Dennis should try since he was smallest. But the opening was too small. We had to dig.

With prodding and digging, a large rock on the right dislodged. Hope arose. Chuck threw out a large rock and yelled, "Snake!"

"What kind?" I asked.

Chuck, not being fond of snakes, replied in absolute terror, with some obscene remark.

I saw it was a garter snake and swore never to let Chuck forget it. The snake jumped down the hole and Chuck allowed Dennis to finish digging.

Actually, it was time for Dennis to take a break, but Dennis didn't know what it was to stop once he had started digging. Chuck and I took the rocks away as Dennis passed them to us. Meanwhile, the sun got closer to the horizon and the air got a night chill.

Dennis announced if we could remove one more boulder, the hole would be open. We gave him a retired piece of tenstrong, he tied it around the boulder. Just as Chuck and I prepared to pull like hell, Dennis knocked loose one or two smaller rocks and all I saw was the end of the tenstrong disappearing down the entrance. This was followed by a thud.

Now the hole was big enough for Bill (Stringfellow) or Gary (Moss) to get through.

Again, we donned our caving gear. Chuck told Dennis he could go first, since he had done all the work. Actually, I think Chuck was afraid of the snake, which was surely crushed.

We rigged a rope and Dennis rappelled and took the left passage. Chuck followed, going right. Dennis said he could see Chuck's light from where he was -- and that the entrance didn't have to be rappelled. I rappelled in, following Chuck's path.

We followed the passage, admiring the virgin passage and noting where to find our way out. I was really impressed, being a trainee and seeing my first virgin cave. Continuing along the passage, we crawled through some small breakdown and down through some really loose shale which broke if you even thought of using it as a foothold. This brought us to a room above a drop which appeared to be 40 to 50 feet deep.

The floor we were on was really bad. A stream ran through the middle, coming in on the left. From above, we had seen a passageway across the area where we were. We climbed over a conglomerate boulder that broke in our hands as we climbed, then up the wall to the passage. At its entrance, there was a rock that looked like a mallard in flight. The passage became the Duck Walk. Someone short could duck-walk this passage. It ran 75 feet. We noted soda straws and rimstone pools along the way.

The Duck Walk ended at some breakdown. We were tired. We wanted to go back to the party. We decided not to push more passage. We sat down and had a gorp break. Going down from the Duck Walk above the pit was scarey, with so much exposure. The floor beside the conglomerate rock was small pebbles and loose rock, which fell through an opening where the water went down in the floor.

Past this, up the shale we went. Back at the entrance, we were tired, happy, and felling triumphant about our new cave -- Spring Hollow.

"If you cannot bear the silence and the darkness, do not go there; if you dislike black night and yawning chasms, never make them your profession. If you fear the sound of water hurrying through crevices toward unknown and mysterious destinations, do not consider it. Seek out the sunshine. It is a simple prescription. Avoid the darkness.

It is a simple prescription, but you will not follow it. You will turn immediately to the darkness. You will imagine that you are tired of the sunlight; the water that unnerve you will tug in the ancient recesses of your mind: the midnight will seem restful -- you will end by going down."

-- Loren Eisley

("THE NIGHT COUNTRY")

submitted by Jan Roote

Number One Was . . . . .

Ever wonder how the VPI Cave Club's membership number system started?

Research in the club files turned up the following reports given when the numbering system was initiated:
Minutes Oct. 23, 1964:

Gary McCutchen- Membership Committee- "There are two signifiacant plans for changing the membership cards: one to change the wording Virginia Polytechnic Institute to VPI Cave Club; two, to give the standing members numbers for their cards, beginning with the oldest members. (This is to keep a perminant list of club members.) Also the cards may have color. The above mentioned plans were made into a motion and passed. A motion was also made and seconded to have an imprint of the Troglodyte, the 'Hairy Ape'."
Minutes Nov. 6, 1964

Membership Card Committee- "The new membership cards were presented along with the number system. Tom Bell moved that the numbers be accepted as they stand. The motion was seconded by Whitt Whittemore and passed by the club."

The numbers given to current members at the beginning of the numbering system were not in chronilogical order and members before the fall 1963 were not included unless they returned as dues paying members.

The club reached number 208 this November.

What about number 12, 19, 51, 81,or 91 not to forget number 115, 121, 128, 149, or 155 ? If you go to a Virginia Region meeting, NSS Convention or Old Timers reunion you may run across many of these VPI'ers. Not to mention the numbers that show up at the Cave Club Banquet in February or that slip into the seats in the back of the meeting hall on Friday nights.

Ed Bauer- was number 1
2- Bob Mallis
3- Pat O'Meara
4- Sam Dunaway
5- Gary McCutchen
6- Tom Bell
7- John Eads
8- Tom Lamons
9- Betty Lamons
10 Joyce Slaughter
11 Rick Nolting
12 R.E. Whittemore
13 Art Wadsworth
14 Craig Peters
15 Joe Smith
16 Sally Carlson
17 Mike Bohn
18 Doug Cochran
19 Ed Morgan
20 James Waid
21 Mike Yuso
22 Paul Helbert
23 Dixon Hoyle
24 Byron McCutchen
25 Mike Hamilton
26 J.F. Cooper
27 Jack Keat

28 John Peduzzi
29 E.B. Baker
30 Tom Vigor
31 Ed Brown
32 Dave Strope
33 Jat Murray
34 Henry Stearns
35 Mallory Hightower
36 Wayland Moore
37 Alan Armstrong
38 Tony Graham
39 Addison Wilkins
40 Whitey Eubank
41 Carole Noble (Park)
42 Richard Gerling
43 Annie Braithwaite (Whittemore)
44 Tom Roehr
45 Larry Wuensch
46 Bob Swensson
47 Hank Harjes
48 Richard Beck
49 Lane Goodall
50 John O'Meara
51 Bob Simmons
52 Rick Keener
53 Glen Davis
54 Bob Williams
55 Steve Evens
56 Cletus Lee
57 Berry Whittemore
58 Henry Stevens
59 Doug Yeatts
60 Rick Johnson
61 Wes Thorne
62 Gene Harrison
63 Gary Skaggs
64 Gearge Stonikinis
65 Henry Marshall
66 Ray Womack
67 Phillip Young
68 Tom Harris
69 Tina Noble
70 Gary Moss
71 Bob Amundson
72 Don Laffoon
73 Mike Frieders
74 Danny Wright
75 David Yolton
76 Mike Keenan
77 Dave Mc Clay
78 John Atthowe
79 Bruce Patterson
80 Terry Pick
81 Jim Dawson
82 Carl Eddy
83/0 Ed Day
84 Russell Peterson
85 Mike Kayes
86 Steve Hall
87 Chris White
88 Linda Heitz
89 Bob Barlow
90 Dale Parrott
91 Eileen Alderidge
92 Steve Kark
93 Bruce Byrd
94 Arabia Benitez Pick
95 Bill Park
96 Sharon Priest
97 Roy (Phantom) Clark
98 Doug Perkens
99 Phil Moritz
100 Dick Washinton
101 Winston Harmon
102 Diana (Sandy) Weber
103 Bruce Mills
104 Steve Williams
105 Sarah Critzer
106 Mike Clifford
107 Dee Snell
108 Theresa Huttlinger
109 Jan Nelson
110 Lynn Vinzant
111 Ed Loud
112 Pete Schnaars
113 Karen (Boots) Good (Yeatts)
114 Guy Turenne
115 Bil Douty
116 Karl Berge
117 Jim Hurd
118 Craig Ellenfield
119 Paul Broughton
120 Frank Garrett
121 Janet Queisser
122 Libby Hecker

123 Dennis McCleavy
124 Jim Hixon
125 Doug Draves
126 Tom Speers
127 Jim Talmadge
128 Mike Conefrey
129 Neal Nelson
130 Steve Riordan
131 Mike Frame
132 Nancy Wick (Hamm)
133 Howard Dame
134 Larry Cooke
135 Liz Leach (Morgan)
136 Dennis Webb
137 Rick Weber
138 Robin Lefon (Loud)
139 Larry (Tuna) Johnson
140 Don Davison
141 Ned Columan
142 Mike Hogan
143 Pam Mohr (Douty)
144 Karl L. Hamm
145 Bob Page
146 Randy Stoutenburgh
147 Twila Youngman (Frieders)
148 Ed Richardson
149 Cheryl Jones (Davison)
150 Robyn Wick
151 Kevin T. Cross
152 Bob Lewis
153 Sandy Parham (Peterson)
154 Bill Stringfollow
155 Rolf McQueary
156 Richard Lutz
157 Jim Altman
158 Mark Slusarski
159 Ann (Jan) Davis
160 Toralf Brecht
161 S. Michael Richardson
162 Robert Alderson
163 Tom Calhoun
164 Buddy Bundy
165 Jim Denton
166 Jerry Redder
167 Cathy Dancy (Parrott)
168 Nancy R. Moore
169 Randy Wood
170 Keith Ortiz
171 Kathy Cronau (Wood)
172 Rick Whitt
173 Herb Safford
174 Mike Wolf
175 Don Anderson
176 Joe Saunders
177 Lor Windle
178 Carol Godla (Bearden)
179 Doug Olson
180 Jim Bearden
181 Dave Coombs
182 Bob Mead-Donaldson
183 Jeanne Griffin
184 Marjie Lewter
185 Donnie (Cornhole) Carter
186 Ed Devine
187 Doug Thompson
188 Chuck Shorten
189 Dennis Vaders
190 Carolyn Lewis
191 Susanne Sutherland (Frame)
192 Pam Foiles (Wolf)
193 Pete Sauvigne
194 Rick Cooper
195 Dave Bell
196 Phil Sica
197 Paul Kirchman
198 Bill Koerschner
199 Joe Zokaites
200 Dennis Murray
201 Richard (Boo) Croft
202 Ben Johnson
203 Jeanne Nye
204 William Stephens
205 Winfield Wright
206 Eric Harper
207 John Dec
208 Dave Shantz

Signs of Life at VPI

The sign-out sheets, meeting minutes and trainee sheets prove that there are signs of life in the VPI Cave Club. Here are some excerpts:

From the sign-out sheet:

10-16-76 Dead Cat Cave Carter, Devine & Davison
"Koerschner and Eller know where it is."

10-30-76 Pig Hole Chuck Shorten, Don Davison
"To cross the impossible lip! To go where no man has gone before (We did)."

11-7-76 Miller's Cove Windle & trainees
"Sparkling clean and new."

12-4-76 New River Olson, Devine
"FLASH!"

1-8-77 Clover Hollow Perkins, Wolf, Lor, Mead (minus John minus Phil)
"Wolf, what can I say?"

1-21-77 Virginia Lime Koerschner, Kirchman, Alderson, Sauvigne
"Chalked up another 1200' of virgin passage. It squealed when we went in."

2-11-77 Breathing Mead, S. Frame, Voit
"Open. Full of Boy Scouts and cavers."

8-23-77 Greenville Saltpeter String, Armstrong, Chancles
"Caves are dirty."

9-27-77 Virginia Lime Alderson, Devine, Carter, R. Loud, Kirchman, Koerschner, Phil, Joe
"Approximately 800', no scoops, many leads mapped out, dozens left."

4-7-77 New River Eller &3
"No hits no runs no errors!"

4-16-77 Salamander McQueary, J. Davis, R. Loud, Bob Alderson, Ed Devine, Ken
"The end is near. . . perhaps."

8-19-78 Spring Hollow Bil Koerschner, Paul Kirchman, Frank Kirchman
"Mapped one lead, 30'. Bust."

9-23-78 Spring Hollow Bill Koerschner, B. Stephens, Wynn, Paul
"Forgot brunton. Hammered into 400' virgin passage, new domes, resketched some old surveys and crapped out leads."

9-30-78 Clover Hollow Paul Kichman, Bill Stephens, Bill Sydor, Jay Kennedy
"I hate sport caving!"

9-30-78 Laural Creek Perkins, Bell, Redder, Paul Bizier, Jim Dunyak
"Redder 2; Groundhogs 0."

10-28-78 Harmon's Avalanche Pit Ed Devine, Paul Kirchman, Jan Roode
"Busted ourselves in nasty crawls. Ed is a #%¢&*ker. Didn't give ourselves time to finish."

From the minutes:

4-21-78 Don Anderson annouced the New river Grotto is still alive and kicking.

5-5-78 Blue Ridge Grotto wants to find out if there are any caves in Roanoke County.

10-6-78 Bob Alderson needs material for the Trog.

2-10-78 Doug reported that the bottles staged a surprise attack on Brush Mountain. The only injury was Bob Mead's car which suffered 5 bullet wounds.

10-20-78 Don Anderson, Pete Sauvigne and Bob Alderson jumped off the New River Gorge Bridge and were frustr-ted in their effort to committe suicide by a single strand of rope.

10-27-78 Dennis Vadrrs, Dave Bell, Dave Shantz, Hugh Beard and Jeanne Nye went in a local VPI hole in the ground.

4-14-78 Bill Koerschner is going to Spring Hollow Saturday to break the depth record for Bland County.

5-5-78 Bill Koerschner is going back to Spring Hollow and as usual he needs a sucker for lead tape.

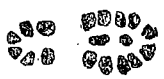
From trainee sheets:

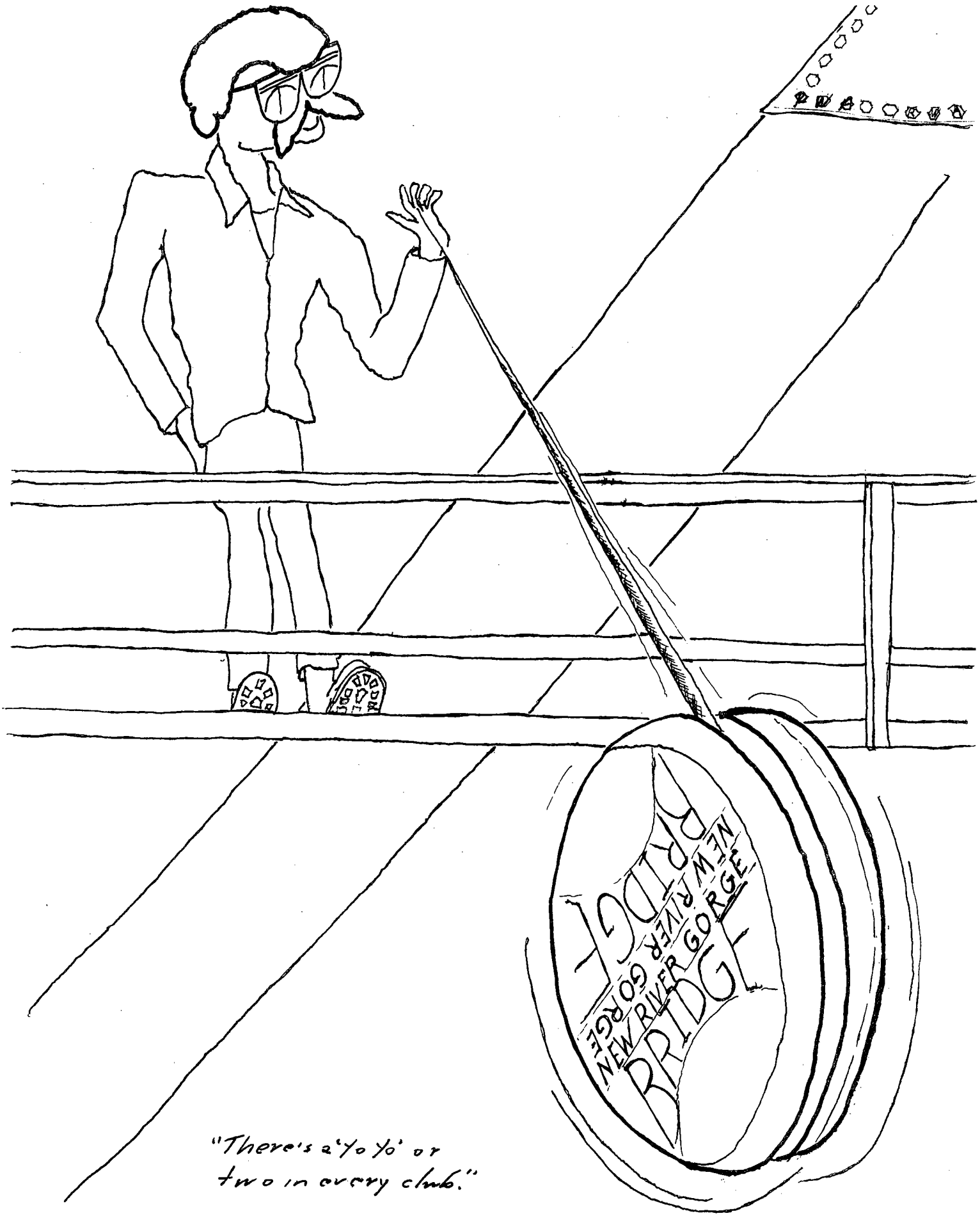
John Dec:
Endorsed by Ed Loud, "Agreed in a drunken stupor, he's hiding out at the Hokie House."

David Shantz:
9-23-78 Link's Jeanne Nye "He's GREAT in a cave."

Bill Stephens:
Spring 78 Matachock Bob Alderson "He liked the cave very much and promised to go back if I'd vote for him."
March 78 Bone Norman Ed Devine "Pushed a lead Douty wouldn't map."
Rappling and Prussiking Paul S. Kirchman "He got out and all he had was knots, so he must have used them."

Winfield Wright:
10-7-78 Tawney's Don Anderson "Conservation trip, he picked up everything but bat droppings."





"There's a 'Yo Yo' or two in every club."

The Microbiology of Cave Waters

by Chuck Shorten

(What you don't know about the water wouldn't hurt you)

INTRODUCTION

The microbiology of cave waters is an interesting new area of study in biospeleology, and many preconceived ideas are being proved wrong. Early theories contended that cave waters undergo filtration and consequent sterilization as they pass through calcareous* strata, and should therefore contain little or no microbial life. This has been shown to be very wrong; in fact, stream waters may show a microflora quite similar to that of the surface waters nearby. The differences which are the most significant are the total darkness of caves (hence the lack of obligate photolithotrophs), the high mineral content of dripwater pools, and the effects of organic pollution inputs on normal microbial populations.

Three different aquatic systems exist in caves: stream water, standing dripwater pools, and layers of water found on the surface of cave walls and formations. There is great species diversity between the various systems, and bacterial counts are often several orders of magnitude different from one water source to the next. One study of sediments taken from a standing pool and a stream pool showed a population of bacteria in the standing pool almost 20 times as large as that in the stream pool (Dickerson, 1975). This result seems reasonable, for the high mineral content of the dripwater pool can supply the energy necessary for a population of autotrophic bacteria.

Much of the current research in cave water microbiology is directed towards the effects of pollution on cave waters and the normal microflora of these systems. Other investigations have developed correlations between high bacterial numbers and animal congregations (Dickerson, 1975). Both biological and chemical parameters have been used to describe water quality in caves (Elliot, 1976). Additional research in this area has been conducted to

* A glossary for such terms appears at the end of this article.

study the antibiotics found in the soils and waters of caves (Ford and Cullingford, 1976).

ORGANISMS FOUND IN CAVE WATERS

Heterotrophic microorganisms

Cave waters usually contain a limited amount of organic material, and this limited energy source is utilized by heterotrophic microorganisms. Bacteria, algae, and fungi are all found in cave waters. Of particular interest to the microbial ecologist are the coliform bacteria found in the waters of polluted cave systems. One study compared the waters of a cave contaminated by septic tank leakage to those of a similar yet unpolluted cave water system. The difference in the numbers of coliforms was quite pronounced (Holsinger, 1966). Other sources of organic material in cave waters are: accumulations of wood and debris brought in by periodic flooding, feces from bats and other visiting mammals, and the decaying bodies of bats and cave insects.

Some of the heterotrophic bacteria isolated from dripwater pools in caves in South Wales are listed in table 1 below:

Table 1
(Mason-Williams, 1966)

Aerobacter aerogenes	(r)	Chlamydobacteria	(f)
Azotobacter aquatilis	(f)	Clostridium pasteurianum	(f)
Bacillus cereus	(f)	Cytophaga sp.	(s)
B. cereus var. mycoides	(f)	Escherichia coli, irregular	(r)
Bacillus sp.	(f)	Micrococcus denitrificans	(f)
Bacterium qualis	(s)	Micrococcus spp.	(f)
Bacterium sp.	(f)	Nocardia sp.	(s)
Caulobacteria	(f)	Streptomyces sp.	(s)

The frequency of isolations are shown as follows: f=frequent, s=occasional, and r=rare.

The genera Bacillus, Micrococcus, and Nocardia function in nucleic acid

metabolism, and some Streptomyces have been identified as antibiotic producers. Some of these heterotrophs may also function as facultative autotrophs (Alexander, 1977). E. coli can be isolated from pools with an increased organic pollution input, and often this input is attributable to the presence of man (Mason-Williams and Benson-Evans, 1966).

The presence of heterotrophic algae in cave waters is well documented, but most algae isolated from total darkness zones of caves lack chlorophyll. A study involving the placement of normally pigmented species from the Chrysophycophyta, the Chlorophycophyta, and the Cyanophycophyta into caves and cave-like conditions showed that some species could make the switch from photolithotrophy to heterotrophy and use the available carbohydrates as their energy source (Kol, 1966). In addition, when inorganic media was used (simulating a drip pool or formation surface) some species could still develop and produce chlorophylls. The algae which grew best in the totally dark cave environment were: Lyngbya lagerheimii, Monodus subterranea, Phormidium foveolarum, Chlamydomonas, and Chlorella (Kol, 1966).

Fungi are particularly abundant in caves, and are also present in cave waters. Their distribution ranges from sparse to dense, and at times fungal hyphae may be visible in streams. The most commonly isolated species are the Phycomycetes Achlya and Saprolegnia (Ford and Cullingford, 1976).

Autotrophic microorganisms

Perhaps the most interesting aspect of the microbiology of cave waters is the presence of autotrophic microorganisms. Most cave waters, with the exception of fast flowing streams, have a higher mineral content than do surface waters. It seems logical that there should be microbes which can utilize this energy source. Organisms typically found and reported on

include sulfur oxidizing and reducing bacteria, nitrifying bacteria, and iron oxidizing bacteria.

The most frequently found sulfur oxidizing bacteria of cave waters include species of Thiobacillus such as T. thiooxidans and T. ferrooxidans (Ford and Cullingford, 1976). T. thiooxidans can use sulfur in any incompletely oxidized form, and this energy source is frequently found in cave waters. With elemental sulfur, it derives energy via equation 1 below:

Equations
(Ford and Cullingford, 1976)

1. $2S + 3O_2 + 2H_2O \longrightarrow 2H_2SO_4$

2. $2NH_3 + 3O_2 \xrightarrow[\text{(Nitrosification)}]{\text{Nitrosomonas or Nitrosococcus}} 2HNO_2 + 2H_2O + \text{energy}$

3. $HNO_2 + \frac{1}{2}O_2 \xrightarrow{\text{Nitrobacter}} HNO_3 + \text{energy}$ (Nitrification)

Another species of Thiobacteria found in cave waters in Beggiatoa, which frequently oxidizes the hydrogen sulfide present (Vandel, 1965).

Sulfur reducing bacteria are predominantly anaerobes, and one species commonly found is Desulfovibrio desulficurans (Ford and Cullingford, 1976). This organism obtains its growth energy from a mixture of sources, and similarly to Thiobacillus, is a facultative autotroph.

The process of nitrification by aquatic cave microorganisms is two-step; the first step is the conversion of ammonia to nitrite and the second step is the conversion of nitrite to nitrate. These conversions, along with the organisms typically associated with them are shown in equations 2 and 3 above, respectively.

The frequency of occurence of nitrifying bacteria in pools and films

of water from several caves in South Wales is described as "occasional" for Nitrosomonas and Nitrosococcus and "frequent" for Nitrobacter (Mason-Williams, 1966). None of these pools are fed by water from the main streams in the caves.

Denitrification also occurs to a limited extent in cave waters, but this is primarily a heterotrophic process (Ford and Cullingford, 1976). Other autotrophic bacteria present in the nitrogen cycle of cave waters are the nitrogen-fixing bacteria, Azotobacter spp. and Clostridium spp. (Mason-Williams and Benson-Evans, 1966), but these occur on a much smaller scale.

The iron-oxidizing bacteria are often found in areas of the cave with little or no organic material input; these bacteria are poor competitors with other heterotrophic microbes. Substances which appear to be toxic to them include nitrate and ammonium ions and sulfides, which excludes their presence from pools filled by drip sources containing hydrogen sulfide (Caumartin, 1963). Typical species found in cave waters and sediments include members from the genera Siderococcus and Sideronema.

IMPORTANCE OF CAVE WATER MICROORGANISMS

The most important contributions of the microflora of cave waters are the roles they play in the food chain and their relationships to other cave dwelling organisms. The decompositional as well as productive aspects are considered here, and the cave offers a rather simple yet natural setting in which to study these interrelationships.

Decompositional role

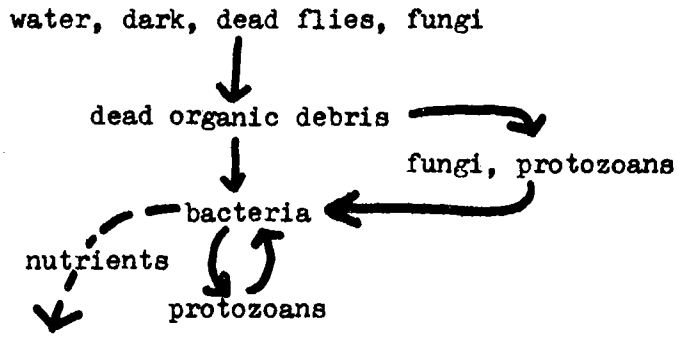
The decompositional role of cave water microorganisms is two-fold (Moore and Nicholas, 1964). Primarily, the hererotrophic microbes act as scavengers and break down the waste materials left by other cave dwellers.

Secondly, they release these broken-down materials which in turn serve as nutrients for other organisms. In this manner, these microbes prevent the accumulation of organic debris and serve a productive role as well.

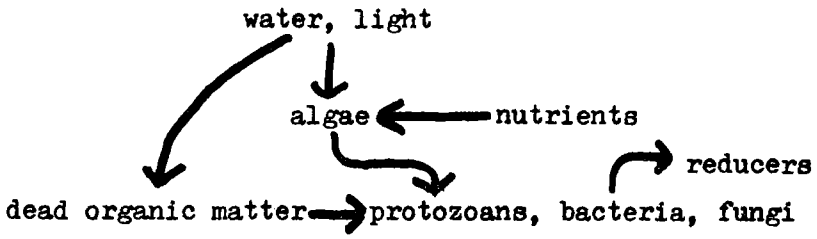
Productive role

The productive role of autotrophic cave water microorganisms is almost parallel to that of the heterotrophic bacteria, for they turn relatively unusable inorganic minerals into usable forms. Their biomass, in turn, can be a valid carbon source for other organisms in the food chain. The food chains illustrated in figure 1 below represent two microecosystems from pools in Lehman Cave, Nevada:

Figure 1
(Stark, 1969)



A. Aquatic habitats in the dark with dead flies supporting fungi, floating on water surfaces, dead organic matter settles to the bottom and provides food for bacteria and protozoans. Chemotrophic iron bacteria are often present.



B. Aquatic habitats (pH 7.0-8.2) in light with algae, dead organic matter such as flies, bats, wood, algae,

or dung providing food for protozoans, bacteria, or fungi. Iron bacteria may be present.

In case A bacteria play a central role as both decomposers and producers. Case B presents the bacteria as decomposers only. Both of these microecosystems could exist in any cave.

PRODUCTS OF CAVE WATER MICROORGANISMS

Several products are a direct result of the metabolism of microbes in cave waters, and of particular interest here are the antibiotics, vitamins, and odors.

Antibiotics

As early as the 16th and 17th centuries a mineral found in caves called "moonmilk" was used to stop bleeding and as a dehydrating agent (Moore and Nicholas, 1966). It was later found that actinomycetes isolated from water drippings of the cheese-like calcite mineral have antibiotic capacities. Several species of green and blue-green algae have been found associated with moonmilk. Production of this mineral is caused by an upset chemical equilibria in the normal formation of the calcite crystal, and the antibiotic-producing actinomycetes are responsible for this (Caumartin, 1963).

Vitamins

Another product of cave water (and soil, predominantly) microorganisms is the vitamins which are required for the growth of certain troglobitic species. The Thiobacteria commonly found in cave soils and waters are capable of synthesizing substances such as nicotinic acid, pantothenic acid, riboflavin, pyridoxine, and vitamin B_{12} (Vandel, 1965). The ability to produce vitamins is not unique to microbes of the cave environment, however, as similar capacities have been demonstrated in surface soils. The important

difference is that in the cave ecosystem (aquatic or soil), the input of vitamins may be restricted to those produced by microbes.

Odors

The musty smell of caves is caused by the presence of actinomycetes in soil and water.

THE MICROBIOLOGY OF POLLUTED CAVE WATERS

Much of the current research in cave microbiology deals with polluted water, mainly because caves are often used as water sources. Of particular interest is the very nature of the cave passage itself, and one study reported:

> Pollution is particularly serious in limestone areas because of underground connections between caves. Even slight contamination is a serious health hazard and a threat to all the cave dwellers. It may not kill all the troglobites, but it could easily upset the cave community's delicate balance (Poulson and Moore, 1966, p. 191).

Often, a cave may appear to be an excellent site for sewage disposal, and this is what happened in one Kentucky cave system in the post World War II years:

> They piped raw sewage and industrial wastes into rock crevices that led into the underground stream. By 1946 the cave had such a stench that it could not be visited (Poulson and Moore, 1966, p. 191).

The cave mentioned had formerly been a very popular tourist cave.

Pollution can enter a cave through any of several inlets. The most common ways for organic pollutants to enter a cave'a water system are through direct seepage, flooding, or dumping in"sinking" creeks or rivers. Other, less significant ways are through air currents and by cave visitors (excluding fecal input).

In another study, pools of water with different degrees of organic input were examined and the presence of coliforms was confirmed (Holsinger, 1966). Four pools were located in Banner's Corner Cave, Virginia and one was in Chadwell's Cave, Virginia. Banner's Corner Cave, with the exception of one pool, is grossly contaminated by seepage of septic tank materials and accordingly supports a large population of coliforms. Chadwell's Cave is not subject to septic seepage, and its coliforms were attributed to feedlot runoff. One of the pools in Banner's Corner Cave contained no visible sewage, and its dissolved oxygen content was significantly higher than those pools visibly polluted.

The single most important feature of this research is the demonstration that aquatic cave systems can become seriously polluted yet still escape the notice of most public health or water quality control agencies. Attempts must be made to trace pollution sources which affect cave waters, for these waters inevitably flow into and contribute to the pollution of other surface water systems.

In the city of Bowling Green, Kentucky, one researcher examined the quality of water in seven caves using both chemical and biological parameters (Elliot, 1976). In this report it was suggested that the total coliform count might be a more reliable indicator of pollution than the fecal coliform count. For all seven of the cave systems studied, total coliform counts were over 5,000/ml, the maximum permissable by the Kentucky Water Commission for a public water supply. Serious issues are raised when, despite this evidence, no standards exist for cave waters.

CONCLUSIONS AND COMMENTS

The waters of cave systems are far from sterile, as was thought by early investigators. Populations of heterotrophic and autotrophic

microorganisms are found in virtually every source of cave water, and the problems of lack of light for photosynthesis and comparatively limited organic nutrient input are apparently overcome. Contamination with pollutants from outside sources occurs regularly in some cave waters, while others are subject only to input from intermittent drip sources. The microbiology of cave waters is a dynamic study area, and the sometimes delicate ecosystems involved offer unique opportunity to understand in situ species interrelationships.

Research in the area of cave water microbiology, not unlike other areas of research, is plagued by its own special problems. Remoteness, difficulty reaching some sampling areas, and limitations of cave terrain to most investigators have caused most research to be conducted in more accessible cave areas. With this in mind, what is accessible to the average investigator is also accessible to other cave visitors. Certain out-of-the-way, difficult to reach places may be excellent sites for the isolation of microbial species found in caves only, but the sites typically investigated may be subject to human influences not found in more remote cave areas. Work in areas of caves where the casual cave visitor is unlikely to go must be conducted in order to more accurately evaluate the uniqueness of cave waters as a microbial habitat.

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GLOSSARY

Actinomycetes: a group of filamentous, unicellular bacteria which somewhat resemble the lower fungi.

Autotrophic: pertaining to the ability of an organism to synthesize new cellular material from inorganic substances.

Calcareous: containing calcite, calcium carbonate, or calcium.

Coliform: a type of bacteria usually associated with the intestine of animals and man; used as an indicator of pollution levels in water.

Facultative: able to grow either in the presence or absence of a particular environmental factor; e.g. light, oxygen, organics, etc.

Heterotrophic: pertaining to the ability of an organism to grow on an organic substrate without additional carbon or energy sources.

Obligate: in contrast to facultative, the inability to grow without a particular environmental factor.

Photolithotrophic: pertaining to the ability of an organism to use light energy and carbon dioxide (CO_2) to grow without other carbon sources.