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Prevalence and Distribution of *Aeromonas hydrophila* in the United States

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The abundance of *Aeromonas hydrophila* was measured in 147 natural aquatic habitats in 30 states and Puerto Rico. Viable cell counts were used to estimate density at all sites by using Rimler-Shotts medium, a differential presumptive medium for *A. hydrophila*. Temperature, pH, conductivity, salinity, and turbidity were measured simultaneously with water sample collection. The density of *A. hydrophila* was higher in lotic than in lentic systems. Saline systems had higher densities of *A. hydrophila* than did freshwater systems. *A. hydrophila* could not be isolated from extremely saline, thermal, or polluted waters, even though it was found over wide ranges of salinity, conductivity, temperature, pH, and turbidity. Of the water quality parameters measured, only conductivity was significantly regressed with density of *A. hydrophila*.

Aeromonas hydrophila has long been recognized as a pathogen in amphibians (3, 18), reptiles (13, 18), fish (4, 8), snails (14), cows (20) and, more recently, humans (1). Indeed, several cases of fatal human septicemias caused by *A. hydrophila* have been reported (1), but in all instances the patient was debilitated by some other disease, e.g. leukemia (1). Only recently (1) has *A. hydrophila* been reported to invade and be pathogenic in humans when wounds are exposed to water containing *A. hydrophila*.

Commercial and sport fishery losses to *A. hydrophila* may be extensive; for example, in 1973, 37,500 fish died over a single 13-day period in one North Carolina lake (15). Many studies (6, 8, 18) have suggested that densities of *A. hydrophila* in natural bodies of water may be an important contributing factor to epizootics in fish. Indeed, a significant positive correlation recently was found between densities of *A. hydrophila* in a South Carolina cooling reservoir and infection among largemouth bass (*Micropterus salmoides*) over a 3-year period (T. C. Hazen, Ph.D. thesis, Wake Forest University, Winston-Salem, N. C., 1978). Several investigators (18) have also suggested that *A. hydrophila* is cosmopolitan in distribution, although none of these studies presented data to support this assertion. Because *A. hydrophila* is increasing in importance as a fish pathogen (5, 15, 18) and as a potential pathogen of man (1), the relative distribution and abundance of *A. hydrophila* in various aquatic habitats throughout the United States was investigated.

MATERIALS AND METHODS

Sample collection. Water was collected by using a 1-liter, vertical, Lucite Kemmerer sampling bottle (Wildlife Supply Co., Saginaw, Mich.). The bottle was washed with 70% ethanol after each sample was taken (16). A minimum of three samples were placed in separate sterile, 180-ml Whirl-Pak bags (Nasco International, Inc., Fort Atkinson, Wis.) and processed within 30 min of collection.

Viable cell counts. A sample was filtered through a 0.45-μm-grid, 47-mm-diameter membrane filter (Millipore Corp., Bedford, Mass.). Sterifil aseptic systems and Swinnex filter holders (Millipore Corp.) were used for filtration. Dilutions were made by using filter-sterilized sample water. A minimum of 1 ml (total volume) was filtered with each filter; 0.001, 0.01, 0.1, 1.0, 10, and 100 ml quantities or their equivalents were filtered from each site. Filters were placed on pads soaked with Rimler-Shotts medium (19) and incubated at 35°C for 20 to 24 h in a portable incubator (Millipore Corp.). Yellow colonies were counted with a 10× magnifying lens. All density estimates were recorded as colony-forming units per ml. Only filters having between 3 and 100 yellow colonies were used for density estimates. Shotts and Rimler (19) reported that 94% of yellow colonies were *A. hydrophila* when samples on Rimler-Shotts agar were incubated for 20 to 24 h at 37°C; 35°C was used in this study because it resulted in a greater number of positive colonies on membrane filters and was more than 97% presumptive for *A. hydrophila* (Hazen, unpublished results). Positive isolates were randomly checked for the ability to produce cytochrome oxidase. Less than 1% of over 1,000 colonies tested for cytochrome oxidase were negative. From 1,000 isolates that were positive for cytochrome oxidase, 361 were tested for *A. hydrophila* characteristics by using the API-20E system (Analytab Products

TABLE 1. *Water quality and densities of A. hydrophila by sample site*

Mo/Yr	Source[a]	County/state	Temp (°C)	pH	Turbidity (JTU)[b]	Conductivity (μmho cm^{-1})[b]	Salinity (‰)	Density of *A. hydrophila* (CFU ml^{-1})[b]	
								Mean	Standard error
5/77	Mobile Bay	Mobile/Ala.	28	6.8	73	1,750	0.5	135.0	35.0
5/77	Escambia C.	Escambia/Ala.	23	7.6	8	20	0	0	0
5/77	Perdido C.	Escambia/Ala.	25	7.8	84	55	0	170.0	0
5/77	Burnt Corn C.	Kuneco/Ala.	21	7.0	61	110	0	20.0	0
5/77	Murder C.	Kuneco/Ala.	23	7.7	36	25	0	0	0
5/77	Sepulga C.	Conecuh/Ala.	24	6.9	49	210	0	240.0	0
5/77	Alabama R.	Montgomery/Ala.	24	7.4	49	70	0	100.0	51.0
8/76	Badwater Spr.	Inyo/Calif.	18	7.6	81	ND	300	0	0
4/78	Lauenstein Spr.	Alamosa/Colo.	27	5.5	ND[c]	ND	ND	12.0	11.0
4/78	Jenkins Spr.	Hooper/Colo.	48	8.2	ND	ND	ND	2.5	1.9
4/78	Chamberlain Spr.	Saguache/Colo.	54	7.5	ND	ND	ND	2.0	0
9/77	Aspetuck R.	Fairfield/Conn.	18	6.4	ND	5,000	4.0	320.0	81.0
9/77	New Haven Harbor	New Haven/Conn.	18	6.4	ND	31,000	23.0	9,000.0	1,000.0
9/77	East R.	New Haven/Conn.	20	6.5	ND	33,000	25.0	35.0	25.0
9/77	Hammouassett R.	Middlesex/Conn.	18	7.2	ND	6,000	5.0	100.0	10.0
9/77	Memunketesuck R.	Middlesex/Conn.	18	7.1	ND	15,000	10.0	27.0	3.0
5/77	Shoal C.	Troup/Ga.	20	7.5	49	55	0	16.0	6.0
5/77	Chattahoochee R.	Troup/Ga.	18	7.2	49	28	0	62.0	8.0
8/76	Bear R.	Bear/Idaho	18	7.9	123	ND	ND	60.0	0
8/76	Bear L.	Bear/Idaho	20	8.2	47	ND	ND	0.1	0
8/76	Wabash R.	White/Ill.	20	7.5	106	ND	ND	0	0
8/76	Big Blue R.	Marshall/Kans.	27	8.5	200	ND	ND	3.0	0
5/77	Ponchatrain L.	Tammany/La.	15	6.9	80	5,500	3.5	28.0	0
5/77	Lafourche Bayou	Lafourche/La.	26	8.1	49	245	0	205.0	5.0
9/77	Little Androscoggin R.	Oxford/Maine	15	5.7	ND	60	0	33.0	4.0
9/77	Webb R.	Oxford/Maine	14	6.8	ND	40	0	53.0	15.0
9/77	Bear R.	Oxford/Maine	14	6.5	ND	40	0	1.2	0.7
9/77	Royal R.	Androscoggin/Maine	15	6.8	ND	55	0	19.0	10.0
9/77	Sabattus R.	Androscoggin/Maine	15	6.7	ND	70	0	110.0	10.0
9/77	Piscatagua R.	Androscoggin/Maine	15	6.6	ND	150	0	16.0	8.0
9/77	Saco R.	Androscoggin/Maine	17	6.8	ND	45	0	9.4	3.8
9/77	Merriland R.	York/Maine	15	6.8	ND	70	0	20.0	10.0
9/77	Oguaquit R.	York/Maine	15	6.8	ND	85	0	10.0	6.0
9/77	Sebasticook L.	Somerset/Maine	5.7	ND	115	0	11.0	2.0	
9/77	Douglas Pond	Somerset/Maine	13	6.8	ND	130	0	4.5	1.5
9/77	Sibley Pond	Somerset/Maine	13	7.0	ND	75	0	0.1	0
9/77	Sennebec R.	Somerset/Maine	13	6.7	ND	75	0	32.0	23.0
9/77	Mercer R.	Somerset/Maine	13	6.8	ND	55	0	0.6	0.3

9/77	Sandy R.	Franklin/Maine	13	6.8	ND	50	0	50.0	20.0
9/77	Fish Brook	Essex/Mass.	15	7.5	ND	110	0	13.0	6.0
9/77	Charles R.	Essex/Mass.	16	8.0	ND	220	0	14.0	5.0
5/77	St. Louis Bay	Hancock/Miss.	24	8.2	65	190	0	15.0	3.0
5/77	Gantian R.	Harrison/Miss.	25	7.6	49	330	0	29.0	9.0
9/77	Wold R.	Harrison/Miss.	22	8.6	51	30	0	16.0	6.0
8/76	Mississippi R.	St. Louis/Mo.	26	7.3	400	ND	ND	0	0
8/76	Grayling C.	Gallatin/Mont.	10	7.9	61	ND	ND	50.0	0
8/76	Cougar C.	Gallatin/Mont.	13	7.4	56	ND	ND	4.5	0.5
8/76	Hebgen Res.	Gallatin/Mont.	16	8.9	30	ND	ND	19.0	2.0
8/76	Madison R.	Gallatin/Mont.	21	7.7	42	ND	ND	60.0	1.0
8/76	North Platte R.	Lincoln/Nebr.	28	7.9	75	ND	ND	41.0	9.0
8/76	North Loup R.	Cherry/Nebr.	27	8.2	59	ND	ND	0	0
8/76	Lake Mead	Clark/Nev.	25	8.7	4	ND	ND	0	0
9/77	Israel R.	Coos/N.H.	13	5.9	ND	45	0	19.0	14.0
9/77	Peabody R.	Coos/N.H.	13	6.2	ND	30	0	1.7	0.3
9/77	Taylor R.	Rockingham/N.H.	16	7.0	ND	270	0	39.0	1.0
9/77	Fourmile Brook	Camden/N.J.	19	7.3	ND	230	0	425.0	0
9/77	Old Man's C.	Gloucester/N.J.	16	7.9	ND	255	0	130.0	20.0
9/77	Craft C.	Burlington/N.J.	17	7.8	ND	130	0	400.0	0
9/77	Crosswicks C.	Burlington/N.J.	18	7.5	ND	120	0	100.0	61.0
9/77	Millstone C.	Mercer/N.J.	18	7.2	ND	100	0	1,000.0	100.0
9/77	Rocky Brook	Mercer/N.J.	18	7.0	ND	130	0	480.0	0
8/76	Rio Grande R.	Dona Ana/N.Mex.	27	8.7	211	ND	ND	300.0	0
9/77	Sandy C.	Jefferson/N.Y.	13	7.0	ND	210	0	40.0	10.0
9/77	Indian R.	Jefferson/N.Y.	14	7.3	ND	95	0	55.0	6.0
9/77	Osutegatchie R.	Lawrence/N.Y.	15	7.3	ND	60	0	18.0	9.0
9/77	Grass R.	Lawrence/N.Y.	15	7.5	ND	60	0	27.0	12.0
9/77	Racquelle R.	Lawrence/N.Y.	14	8.0	ND	25	0	5.0	0
9/77	St. Regis R.	Lawrence/N.Y.	13	7.5	ND	60	0	5.8	1.2
9/77	Deer R.	Lawrence/N.Y.	13	7.8	ND	60	0	10.0	6.0
9/77	Little Salmon R.	Franklin/N.Y.	14	7.5	ND	85	0	55.0	6.0
9/77	Salmon R.	Franklin/N.Y.	13	7.1	ND	55	0	3.4	1.4
9/77	Great Chazy R.	Clinton/N.Y.	14	7.1	ND	130	0	30.0	11.0
9/77	Farm Pond	Cortland/N/Y.	14	7.7	ND	290	0	66.0	14.0
9/77	Chanongo R.	Broome/N.Y.	13	7.8	ND	125	0	450.0	253.0
11/77	Highrock L.	Davidson/N.C.	12	6.9	75	45	0	2.3	0.4
5/77	Cassie R.	Roanoke/N.C.	15	7.6	ND	80	0	37.0	8.0
9/77	Norman L.	Mecklenburg/N.C.	9	7.2	290	ND	ND	10.0	0
8/76	North Yadkin R.	Forsyth/N.C.	26	7.7	51	ND	ND	5.3	1.2
5/78	Catherine L.	Forsyth/N.C.	24	7.5	49	95	0	24.0	8.0
8/76	South Yadkin R.	Iredell/N.C.	23	8.5	395	ND	ND	245.0	55.0
4/77	Belews L.	Stokes/N.C.	20	7.4	8	140	0	5.0	1.0
4/77	Hickory L.	Alexander/N.C.	21	7.2	ND	ND	ND	20.0	6.0
3/77	Albermarle Sound	Washington/N.C.	13	8.2	ND	85	0	1.3	1.3

TABLE 1.—*Continued*

Mo/Yr	Source[a]	County/state	Temp (°C)	pH	Turbidity (JTU)[b]	Conductivity (μmho cm^{-1})[b]	Salinity (‰)	Density of *A. hydrophila* (CFU ml^{-1})[b]	
								Mean	Standard error
4/78	Welch C.	Martin/N.C.	19	6.9	20	100	0	16.0	4.0
3/77	Chowan R.	Chowan/N.C.	12	7.8	ND	58	0	2.7	0.5
3/77	Currituck Sound	Currituck/N.C.	9	5.2	ND	2,790	1.9	8.2	1.8
4/78	North R.	Currituck/N.C.	17	7.0	104	830	0	5.7	2.3
2/76	Hyco Res.	Person/N.C.	13	8.1	ND	ND	ND	3.0	20.0
3/77	Scuppernong R.	Tyrrell/N.C.	13	7.5	ND	138	0	4.0	1.0
3/77	Alligator R.	Dare/N.C.	12	7.0	ND	2,740	19.0	5.1	1.8
5/77	Roanoke Sound	Dare/N.C.	26	7.8	ND	9,000	5.0	0.1	0
5/77	Croatan Sound	Dare/N.C.	26	7.2	122	3,100	1.5	1.8	0.3
5/77	Oregon Inlet	Dare/N.C.	16	7.3	20	49,000	31.5	18.0	5.0
3/77	Roanoke R.	Bertie/N.C.	4	8.0	16	ND	ND	127.0	16.0
3/77	Pasquotauk R.	Pasquotauk/N.C.	12	5.7	ND	120	0	14.0	1.0
3/77	Perquimans R.	Perquimans/N.C.	12	7.2	ND	700	0	5.4	1.1
5/77	Gaston L.	Warren/N.C.	25	7.2	ND	ND	ND	8.6	1.9
11/77	Badin L.	Montgomery/N.C.	15	6.9	16	60	0	22.0	7.0
11/77	Yadin R.	Montgomery/N.C.	9	7.0	36	60	0	21.0	5.0
9/77	Chauaugo R.	Susquehanna/Pa.	14	7.7	ND	80	0	540.0	0
9/77	Nescopeck C.	Luzerne/Pa.	15	8.0	ND	60	0	800.0	0
9/77	Swatana C.	Schuylkill/Pa.	15	7.8	ND	130	0	550.0	50.0
12/77	Paso R.	El Ynque/P.R.	22	7.1	ND	ND	ND	63.0	25.0
12/76	Wateree Res.	Kershaw/S.C.	9	7.6	150	ND	ND	10.0	0
12/76	Ashley R.	Charleston/S.C.	8	6.9	86	ND	ND	25.0	5.0
12/76	Fishing Creek Res.	Lancaster/S.C.	9	7.4	172	ND	ND	10.0	0
5/77	Seneca R.	Anderson/S.C.	15	7.8	61	30	0	100.0	26.0
5/77	Saluda R.	Greenville/S.C.	16	7.5	8	30	0	11.0	1.0
12/76	Cawtaba R.	York/S.C.	9	7.6	120	ND	ND	9.0	1.2
12/76	Saluda R.	Richland/S.C.	7	7.7	16	ND	ND	4.9	2.0
8/76	North Edisto R.	Lexington/S.C.	24	6.9	36	ND	ND	110.0	15.0
8/76	South Edisto R.	Aiken/S.C.	24	7.5	42	ND	ND	15.0	9.0
10/77	Savannah R.	Aiken/S.C.	18	6.2	80	ND	ND	29.0	1.0
10/77	Lower Three Runs C.	Barnwell/S.C.	19	6.8	25	ND	ND	8.0	2.3
10/77	Pond B	Barnwell/S.C.	18	68	25	ND	ND	5.2	2.3
10/77	Par Pond	Barnwell/S.C.	17	7.3	50	ND	ND	1.2	0.6
8/76	Clark Hill Res.	Edgefield/S.C.	28	7.2	ND	35	0	5.2	1.4
8/76	Pactola Res.	Pennington/S.Dak.	22	8.3	4	ND	ND	0	0
8/76	Sheridan L.	Pennington/S.Dak.	23	8.9	4	ND	ND	0	0
8/76	San Antonio R.	Bexar/Tex.	23	8.4	99	ND	ND	300.0	0
8/76	Great Salt L.	Tooele/Utah	23	7.9	64	ND	ND	0	0

8/76	Yuba L.	Juab/Utah	18	7.5	73	ND	ND	38.0	0
9/77	Winoski R.	Washington/Vt.	14	6.1	ND	135	0	34.0	14.0
9/77	L. Champlain	Franklin/Vt.	16	6.5	ND	115	0	28.0	0
9/77	Joe's Pond	Caledonia/Vt.	14	5.8	ND	58	0	1.3	0.7
9/77	Moose R.	Essex/Vt.	12	6.2	ND	40	0	0.4	0.3
9/77	Connecticut R.	Essex/Vt.	14	5.7	ND	55	0	8.3	1.7
9/77	Meharrin R.	Brunswick/Va.	20	8.1	ND	91	0	21.0	5.0
9/77	Swift C.	Hanover/Va.	20	7.9	ND	160	0	100.0	0
9/77	Sianna R.	Carolina/Va.	19	7.5	ND	100	0	175.0	25.0
9/77	Potomack C.	Stafford/Va.	17	7.7	ND	90	0	46.0	23.0
9/77	Ocoquan R.	William/Va.	18	7.5	ND	550	0	80.0	20.0
9/77	Shenandoah R.	Shenandoah/Va.	19	7.7	ND	430	0	3,600.0	0
9/77	Stony C.	Shenandoah/Va.	17	8.1	ND	160	0	1,000.0	0
9/77	Cedar C.	Warren/Va.	18	7.5	ND	330	0	285.0	15.0
9/77	North R.	Rockingham/Va.	19	8.3	ND	300	0	2,000.0	0
8/76	Yellowstone L.	Teton/Wyo.	15	7.8	16	ND	ND	0.5	0.5
8/76	Ojo Caliente Spr.	Teton/Wyo.	32	8.2	16	ND	ND	19.0	1.0
8/76	Firehole R.	Teton/Wyo.	24	8.0	12	ND	ND	15.0	3.0
8/76	White Dome Geyser	Teton/Wyo.	66	6.3	16	ND	ND	0	0
8/76	Goose L.	Teton/Wyo.	18	9.8	0	ND	ND	12.0	2.0
8/76	Midway Geyser Basin	Teton/Wyo.	33	7.8	44	ND	ND	6.3	1.8
8/76	Gibbons R.	Teton/Wyo.	19	7.1	44	ND	ND	0.7	0
8/76	Biscuit Basin	Teton/Wyo.	20	7.8	49	ND	ND	28.0	0
8/76	Madison R.	Teton/Wyo.	20	7.7	8	ND	ND	130.0	0
8/76	Black Sand Basin	Teton/Wyo.	47	7.8	26	ND	ND	0	0
8/76	Yellowstone R.	Teton/Wyo.	15	7.5	20	ND	ND	3.1	0.5

[a] Abbreviations: C., Creek; R., River; Spr., Spring; Res., Reservoir; L., Lake.
[b] JTU, Jackson turbidity units; μmho cm^{-1}, reciprocal microohms; CFU, colony-forming units.
[c] ND, Not determined.

Inc., Plainview, N.Y.). Only nine of these isolates were not confirmed to be *A. hydrophila*.

Water quality. Salinity (per mille), conductivity (reciprocal microohms per centimeter), and temperature (degrees Celsius) were measured in situ with a model 33 S-C-T meter (Yellow Springs Instrument Co., Yellow Springs, Ohio); an Accumet model 150 portable pH meter (Fisher Scientific Co., Raleigh, N.C.) was used to measure pH. Turbidity was measured with a Mini-Spec 20 spectrometer (Bausch & Lomb, Inc., Rochester N.Y.) by converting percent transmittance to Jackson turbidity units (JTU) (11); turbidity was measured simultaneously with filtration.

Statistical analyses. Analyses of variance and regression analyses were performed by using the interactive data analysis program (University of Chicago) and an HP 3000 computer (Hewlett-Packard Co., Cupertino, Calif.). Each water quality parameter was compared with densities of *A. hydrophila* by using regression analysis. Densities of *A. hydrophila* and conductivity were subjected to log (x + 1) transformation before analyses (21) because of their non-normal distrubution. Skewness and kurtosis were used to measure normality. Any statistical probability equal to or less than 0.05 was considered significant.

RESULTS AND DISCUSSION

A total of 147 lotic and lentic habitats were sampled for *A. hydrophila* (Table 1); *A. hydrophila* was isolated at all but 12 of these sites (Fig. 1). Of the 12 sites where it was not isolated, 2 were hypersaline lakes (Badwater Lake, Great Salt Lake), 2 were geothermal springs (>45°C; (White Dome Geyser, Black Sands Basin), and 3 were extremely polluted rivers (Wabash, Mississippi, San Antonio). Thus, of the 12 locations where *A. hydrophila* could not be isolated, 7 could be considered as extreme environments. The other five sites followed no particular pattern and could be due to sampling error (3%). Of the 30 different states in which samples were taken, *A. hydrophila* was not isolated in 5; however, in 4 of the 5, only a single sample was taken.

Saline habitats had a much higher density of *A. hydrophila* than did freshwater habitats, even though the variation in density among saline habitats was much larger than that among freshwater sites (Table 2). Generally, *A. hydrophila* is not considered to be a marine bacterium (7); however, this study indicates that it is found naturally in marine systems which interface with freshwater and that it can be found at all salinities, except the most extreme (>100‰). This observation has been substantiated recently; *A. hydrophila* was implicated in causing ulcer disease in cod (*Gadus morhua*), a strictly marine fish (10). Lotic habitats had significantly higher densities of *A. hydrophila* than did lentic habitats (Table 2). This is somewhat surprising because *A. hydrophila* could be isolated from waters having a turbidity of 0 to 395 Jackson tur-

FIG. 1. *Distribution of A. hydrophila in the United States. Open circles indicate sampling sites where A. hydrophila could not be isolated.*

TABLE 2. *Comparison of densities of A. hydrophila by habitat*

Habitat	Density of *A. hydrophila* (CFU ml^{-1})[a]			No.
	Mean	Standard error	Range	
Freshwater				
Lotic	161	46	3,600–0.4	96
Lentic	20	8	205–0.1	26
All	130	36	3,600–0.1	122
Saltwater	746	688	9,000–0.1	13
Total (saltwater and freshwater)	189	73	9,000–0.1	135

[a] CFU, Colony-forming units.

bidity units. There was, however, no significant regression between turbidity and density of *A. hydrophila*.

The thermal optimum for most strains of *A. hydrophila* is 35°C, and the thermal maximum is very close to 45°C (17). In this study, *A. hydrophila* was isolated from waters having temperatures of between 4.0 and 45.0°C. *A. hydrophila* could not be isolated at temperatures greater than 45°C; the highest densities occurred at 35°C, along thermal gradients ranging from 20° to 72°C (T. C. Hazen, manuscript in preparation).

Water pH did not seem to play a significant role in *A. hydrophila* distribution, because the bacterium could be isolated over the entire pH range of the samples (5.2 to 9.8). In our lab we have found that *A. hydrophila* growth is unaffected by pH's from 5 to 9 and that it is incapable of growth at a pH lower than 4 or higher than 10.

Regression analyses revealed significant relationships between densities of *A. hydrophila* and conductivity ($F = 14.5$; $df = 93$; $P < 0.001$). None of the other water quality parameters showed significant regressions with densities of *A. hydrophila*. It is unlikely that conductivity alone affects the distribution and abundance of *A. hydrophila*, even though inorganic ion requirements have been demonstrated for a number of marine bacteria (12). It is more likely that some unmeasured water quality parameter(s) varies proportionately with conductivity and that it affects the density of the bacterium. Conductivity may be significant, however, as an indicator of aquatic habitats in which high densities of *A. hydrophila* occur.

The cosmopolitan distribution of *A. hydrophila* is at least partly explained by its ability to live under a wide variety of environmental conditions in natural waters. Its densities, as estimated by viable cell count, commonly range from less than 1 cell per liter to several thousand cells per ml, under a wide variety of conditions. Its abundance in natural waters is clearly not controlled purely by allochthonous or autochthonous carbon, because oligotrophic lakes of the Grand Tetons may have densities of *A. hydrophila* comparable to those of bayous of Louisiana. Abundance of *A. hydrophila* in so many different systems would seem to indicate an important role for this bacterium in natural aquatic processes.

Epizootics in fish, caused by *A. hydrophila*, have been largely confined to the southeastern United States (5, 8, 15, 18). Densities of *A. hydrophila* are high in the southeast, but not significantly higher than in other parts of the United States. Biochemical and serological studies of 361 isolates from water and fish throughout the United States reveal a striking similarity (Hazen and Fliermans, unpublished data); however, other investigators have reported that *A. hydrophila* isolated from fish is more virulent than isolates from water, even though all isolates were biochemically similar (2). Recent studies (4, 8, 9) have shown that host stress may be a significant factor in the epizootiology of red-sore disease and, in combination with variability in virulence of *A. hydrophila*, may be of significance in limiting epizootic outbreaks to aquatic systems in the southeastern United States. Clearly, *A. hydrophila*, as a potential pathogen and as an important component of the microflora in aquatic systems, requires further study.

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