

HARMFUL ALGAL BLOOMS OCCUPATIONAL SCREENING PILOT STUDY

Jana E Easom MPH¹, Lora E Fleming MD PhD¹, Alan Rowan MS², Steven Wiersma MD MPH², Judy A Bean PhD¹

¹NIEHS Marine & Freshwater Biomedical Sciences Center, c/o RSMAS University of Miami, 4600 Rickenbacker Causeway, Miami, FL, 33149, USA; ²Florida Department of Health, Tallahassee, FL

ABSTRACT

In 1997, fish kills in North Carolina estuaries were attributed to a new organism, *Pfiesteria piscicida*. Guidelines were developed to diagnose “Estuarine Associated Syndrome (EAS)” as a surveillance tool for persons with reported symptoms and exposure to estuaries. Although *Pfiesteria* had not been reported in Florida, a cryptoperidiniopsis dinoflagellate (a *Pfiesteria*-like organisms (PLO)) had been associated with fish lesions and kills in Florida.

A cross-sectional study was performed to determine the association between occupational exposure to estuarine harmful algal blooms (HABs) and potential human health effects. Florida environmental workers, with estuarine exposure, served as the study population, creating 3 exposure groups: 1) cryptoperidiniopsis exposure, 2) *only* fish kill and/or fish lesion exposure, and 3) a control group. Phone interviews were conducted using a revised EAS Questionnaire to inquire about reported exposure and symptoms.

The study population was a homogeneous group of 53 workers (2 refusals); 41 (80.4%) *ever* exposed to fish events, with 13 (25%) specifically exposed to cryptoperidiniopsis. No participant met the criteria for EAS. The subgroup (n=28) exposed *only* to fish kills/lesions reported more health effects (61%) than those exposed to cryptoperidiniopsis (23%) or the control group (50%) (p=0.08), always associated with Florida Red Tide exposure.

Occupationally exposed workers exposed to HABs in Florida only reported symptoms with Florida Red Tide exposure, not with exposure to a PLO, and there were no cases of EAS. These workers represent an excellent population to follow for future investigations of occupational HAB exposure.

INTRODUCTION

In addition to their impact on other creatures and the environment, harmful algal blooms (HABs) can produce toxins that may be harmful to humans. HABs appear to be increasing worldwide (1-5). Over the past several years, HABs in the mid Atlantic states have been associated with extensive fish kills and reports of variable human health effects associated with exposure to reportedly HAB-contaminated water (6-13). In February 1998, a new marine organism, a *cryptoperidiniopsis* dinoflagellate resembling *Pfiesteria piscicida* morphologically and genetically, was identified in the estuarine waters of the St. Lucie River (Martin County,

FL) in conjunction with fish lesions. No definitive human health effects were reported associated with estuarine water exposure, although there was considerable community and public health concern (10).

A surveillance system of Estuarine Associated Syndrome (EAS) was set up by the Centers for Disease Control and Prevention (CDC) and several states affected by these organisms (ie. *Pfiesteria* and the *Pfiesteria*-like organisms) in 1997, including disease and exposure definitions (11-13).

METHODS

This Pilot Study was a cross-sectional study of persons with extensive occupational estuarine water exposure to investigate self-reported exposure and health effects. The study population consisted of Florida Department of Environmental Protection (DEP) employees whose work involves extensive environmental and laboratory exposure to estuarine waters throughout the State of Florida. Their actual work includes collection of water and marine animal samples, with laboratory processing of these samples.

The questionnaire, adapted from the surveillance of Estuarine Associated Syndrome (EAS) by the CDC with the States (11-13), was administered by telephone. The questionnaire explored self-reported symptoms, geographic estuarine exposure and demographic data, collected anonymously. The protocol for this study was submitted to and approved by the internal review board of the University of Miami Human Subjects Committee.

Florida DEP environmental workers were selected because of their occupational estuarine exposure during normal times, as well as during fish events. Fish events were defined as the presence of the *cryptoperidiniopsis* dinoflagellate, fish kills and/or fish lesions. Individuals from the 6 major field stations throughout Florida were chosen to participate. Since some individuals from different stations joined the crews in the affected areas during the fish events, the unit of analysis in this study was the individual.

A database was created in Epi-Info Version 6 and analyzed using the statistical software SPSS version 8.0 to conduct chi-square analyses and Fischer’s exact tests, and ANOVA and t-tests. Using Query 4.0 software to calculate a sample size for G (groups) times 2; the groups were the three discussed below. With an alpha level of 0.05, the power of this study to detect a difference between the 3 groups was 95%.

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* Fishers Exact Test and ANOVA

RESULTS

The six DEP field stations were composed of 53 individuals; 51 (96.2%) participated with 2 refusals. There were 10 (19.3%) women with 49 (96.1%) Whites and 3 (5.9%) Hispanics. The average age of the study population was 34.00±7.19 years. All participants had received college degrees with 24 (47.1%) finishing graduate school.

With regards to exposure, 41 (80.4%) were “ever exposed to fish events”; 13 (25.5%) individuals specifically reported exposure to the *cryptoperidiniopsoid* dinoflagellate during the peak fish event time of February-April of 1998. The majority of the participants were exposed to estuarine organisms in the DEP laboratories.

Overall Symptoms

Twenty-six (51.0%) of the 51 participants experienced no reported health effects; no individual reported any symptom lasting for more than 2 weeks. None of the participants suffered from memory loss or confusion, nausea, vomiting, or muscle cramps. Respiratory symptoms were relatively common, occurring in individuals who reported concomitant exposure to Florida Red Tide. Of the 13 people exposed to the *cryptoperidiniopsoid* dinoflagellate in St. Lucie River, 10 (76.9%) reportedly experienced no health effects throughout the study time periods.

Ever exposed vs. Never exposed to fish events

There were 41 (80.4%) individuals who had ever been exposed to fish events, including those present at the St. Lucie River events; only 10 (19.6%) individuals had never been exposed to fish events (controls). There were no significant differences between these groups for demographics or reported symptoms.

Table 1. Three Exposure Groups

Variable	Ever Exposed to fish events			*P value
	Never exposed (N=10)	Only exposed to fish kills (N=28)	Exposed to dinoflagellate(N=13)	
Age (mean)	33.87±8.52	35.06±7.77	31.82± 4.17	0.41
Gender	3F (30.0%)	6F (21.4%)	1F (7.7%)	0.35
Race White	10 (100%)	26 (92.9%)	13 (100%)	1.00
Hispanic	1 (10.0%)	2 (7.1%)	0	0.76
Graduate School	7 (70.%)	14 (50.0%)	3 (23.1%)	0.09
Mean yrs employed	4.40±2.72	5.61±4.59	4.15±3.72	0.50
Ever Sympto	5 (50.0%)	17 (60.7%)	3 (23.1%)	0.08

Cryptoperidiniopsoid dinoflagellate vs. fish kills vs. controls (Table 1)

A comparison was performed between 1) the 13 (25.5%) individuals exposed to the *cryptoperidiniopsoid* dinoflagellate, 2) the 28 (54.9%) individuals *only* exposed to fish kills/lesions, and 3) the 10 (19.6%) unexposed controls. There were no significant differences for the demographic variables.

When comparing all three groups with regards to reported experience of any symptoms, no statistically significant difference was found (p=0.08). Although not statistically significant, the group *only* exposed to fish kills (n=17; 60.7%) and even the unexposed controls (n=10; 50.0%) had substantially more people with symptoms than those individuals exposed to the *cryptoperidiniopsoid* dinoflagellate (n=3; 23.1%).

DISCUSSION

This was a cross sectional study of persons occupationally exposed to estuarine waters during and after a major fish event with a new dinoflagellate. None of the study participants met the CDC/State criteria for “Estuarine Associated Syndrome” (EAS) (11-13). An increased prevalence of respiratory symptoms was associated with exposure to known Florida Red Tides; respiratory symptoms have been associated with the aerosolized Florida Red Tide toxins and studies are ongoing (5, 10). The majority of the individuals reporting exposure to the *cryptoperidiniopsoid* dinoflagellate did not report health effects associated with estuarine exposure. Analysis of people *ever* exposed to fish kills compared to people *never* exposed to fish kills showed no significant difference in the report of symptoms. The individuals exposed to the *cryptoperidiniopsoid* dinoflagellate did not have a higher risk of health effects than those with exposure to *only* fish kills or the unexposed control group.

Although there was sufficient statistical power to detect a difference between the 3 groups, multiple comparisons were not taken into account given the relatively small study population. Furthermore, the study information was cross sectional and by self-report; there were no objective measures of health effects, and only limited objective data on exposure. The possibility of biased reporting is present since these workers could either over-report symptoms (to receive workers compensation) or under-report (due to fear of work reprisals). However, the significant response of reported upper respiratory symptoms associated with exposure to Florida Red Tide, consistent with other reports, would indicate that reporting bias was not an issue in this study (3, 5).

This Pilot Study has a number of advantages not seen in the previously published *Pfiesteria*/EAS literature on possible human health effects (6-13). In addition to the high

participation rate, these environmental workers are a uniform group with similar educational and socio-economic backgrounds in a stable job situation. The participants are not necessarily representative of the general population, yet they are an important group of occupationally exposed individuals. They are very highly exposed to estuarine events due to the nature of their work. Therefore, if a dose response relationship is postulated for the health effects possibly associated with exposure to these organisms, then health effects should be seen in this occupational population first and in greatest quantity. Finally, although the study population is small, this study is the largest to date that epidemiologically evaluates individuals with occupational HAB exposure.

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REFERENCES

1. P. Epstein. Marine Ecosystems: Emerging Diseases as Indicators of Change: Health of the Oceans from Labrador to Venezuela. (Harvard Health Ecological and Economic Dimensions (HEED) of Global Change Program, Boston, MA) (1998).
2. P. Epstein P. Am. J. Public Health. 85, 168-172 (1995).
3. D. Baden, L. Fleming, J. Bean, in: Handbook of Clinical Neurology: Intoxications of the Nervous System. FA deWolff (Ed). (Elsevier Press, Amsterdam), pp. 141-175 (1995).
4. F. M. Van Dolah.. Env Health Persp 108 Suppl 1, 133-41 (2000).
5. L.E. Fleming, J.A. Bean, D. Katz, R. Hammond. Hui, Kits, Stanfield, eds. Seafood and Environmental Toxins. (Marcel Dekker, New York) (2000).
6. J.M. Burkholder, E.J. Noga C.W. Hobbs, H.B. Glasgow. Nature. 258, 407-410 (1992).
7. H.B. Glasgow, J.A. Burkholder, D.E. Schmechel, P.A. Tester, P.A. Rublee P.A. J Toxicol Environ Health. 46, 501-522 (1995).
8. L.M. Grattan D. Oldach, TM et al Lancet. 352, 532-539 (1998).
9. J.G.Morris. Maryland Med J. 47(3), 104-105 (1998).
10. K. A. Steidinger, J. Landsberg, C. Tomas, J. Burns. Harmful Algal Blooms in Florida. Florida Harmful Algal

- Blooms Task Force, (Florida Dept of Environmental Protection, St Petersburg, FL) (March 8, 1999).
11. Centers for Disease Control and Prevention (CDC). Morbidity Mortality Weekly Report. 46(40), 951-952 (1997).
12. L.E. Fleming, J. Easom, D.Baden, A. Rowan, B. Levin. Toxicol Pathol. 27, 573-581 (1999).
13. Centers for Disease Control and Prevention (CDC). Morb. Mort. Weekly Rep 49(17), 372-3 (2000).