Food and Agriculture Organization of the United Nations

Cefas

VIRTUAL REGIONAL WORKSHOP ON BIVALVE MOLLUSCS SANITATION

9, 10, 11 December 2020

Overview of hazards associated with bivalve mollusc consumption: Hazard characterisation and risk assessment

James Lowther

Types of hazard associated with bivalve shellfish

TYPE OF HAZARD	SOURCES	GUIDANCE
CHEMICAL e.g. pesticides, heavy metals	Agricultural run-off, industrial discharges etc.	Codex Alimentarius, General Standard for Contaminants and Toxins in Feed and Food, 2009
BIOTOXINS i.e. toxic chemicals produced by marine microalgae	Naturally occurring in seawater, blooms	Assessment and management of biotoxin risks in bivalve molluscs, FAO Technical Paper, 2011
MICROBIOLOGICAL i.e. pathogenic bacteria, viruses, parasites	Human sewage, animal faeces, some naturally occurring in seawater	FAO/WHO Technical Guidance for the Development of Sanitation Programmes **– this workshop**

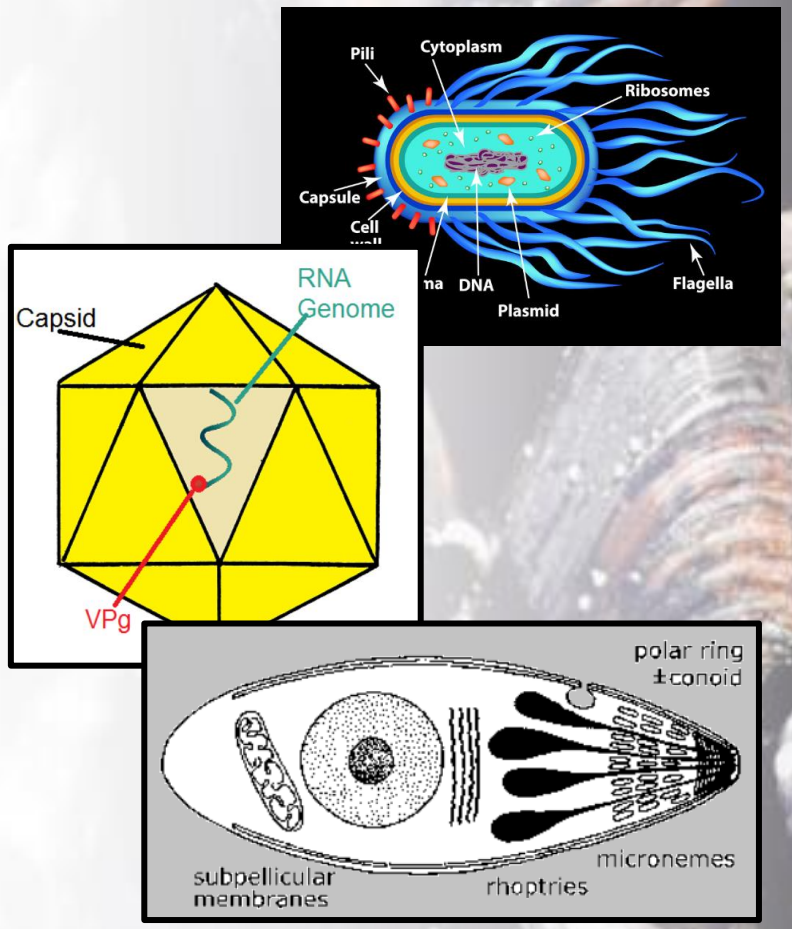
Microbiological hazards

Numerous microbiological pathogens potentially linked to shellfish consumption

BACTERIA — *Salmonella* spp., *Vibrio* spp., *Campylobacter* spp., *Listeria monocytogenes*

VIRUSES — Norovirus, hepatitis A virus, sapovirus, hepatitis E virus

PARASITES — *Giardia intestinalis*, *Cryptosporidium parvum*, *Microsporidia*



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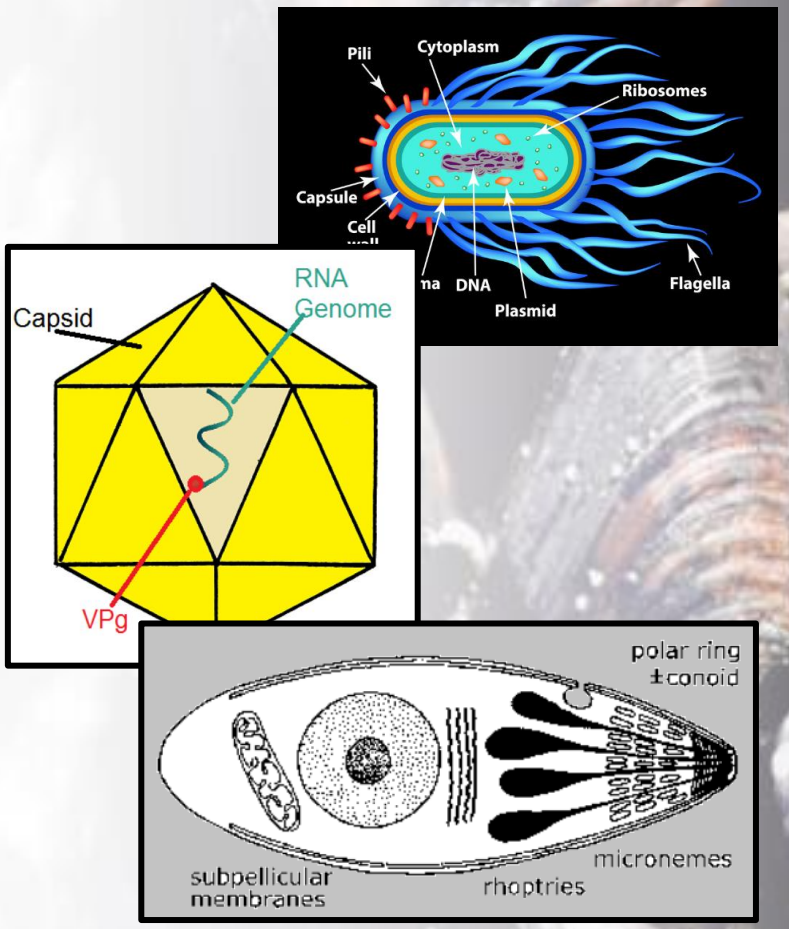


Salmonella enterica serovars Typhi & Paratyphi

- Gram negative bacterium
- Causes enteric fever (severe illness)
- Transmitted in human faeces
- First recorded outbreak due to shellfish consumption in **1894**

The New York Times

TYPHOID FEVER DUE TO OYSTERS.; Wesleyan University Faculty's Explanation of the Recent Epidemic.

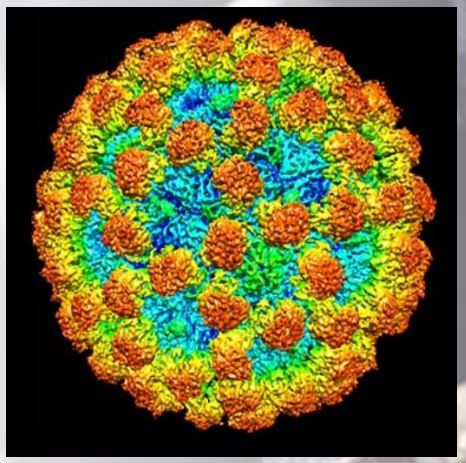
Nov. 14, 1894

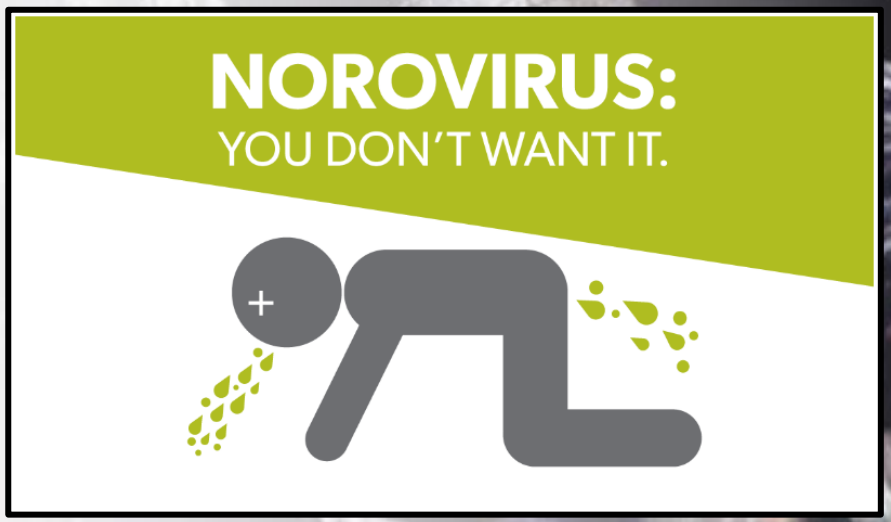
Vibrio parahaemolyticus and *V.vulnificus*

- Gram negative bacterium
- Causes gastroenteritis (Vp; mild illness) or sepsis (Vv; severe illness with high mortality in susceptible cases)
- Naturally occurring in marine environment; associated with low salinity, high temperature coastal waters
- Commonest shellfish–related pathogen in e.g. USA (Vp)

Norovirus

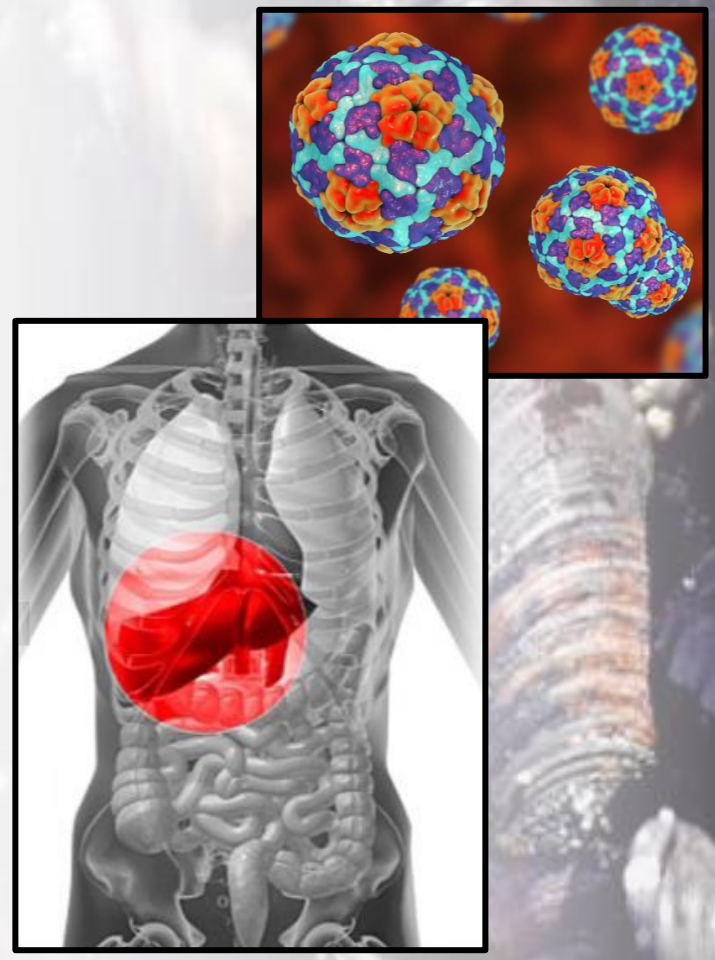
- Single stranded RNA virus
- Causes gastroenteritis (normally mild illness)
- Transmitted in human faeces
- Widespread worldwide
- Commonest shellfish-related pathogen in e.g. Europe
- Highly seasonal occurrence **in some regions**





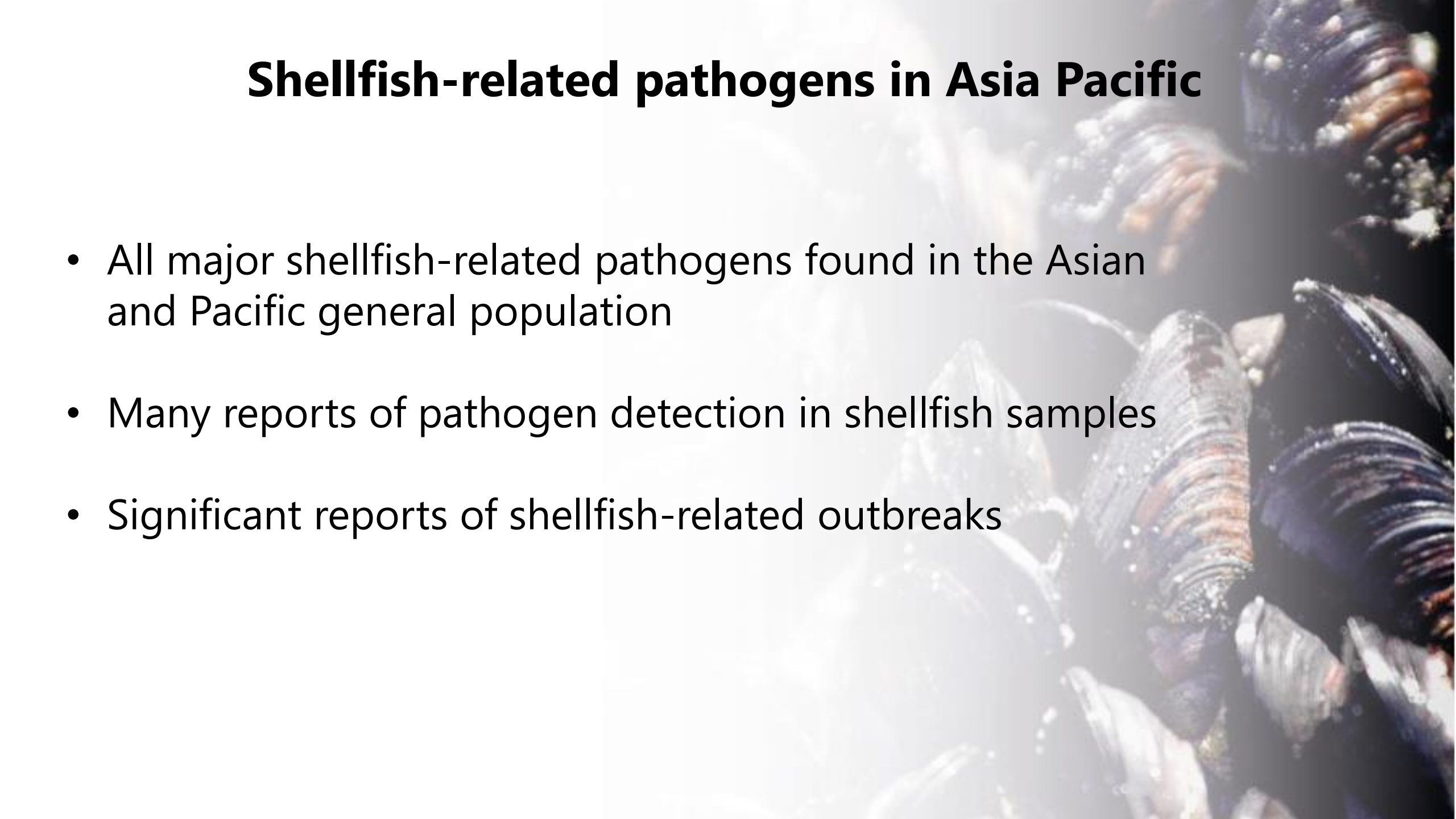
Hepatitis A virus

- Single stranded RNA virus
- Causes hepatitis (moderate illness)
- Transmitted in human faeces
- Frequency in human populations varies widely across the globe



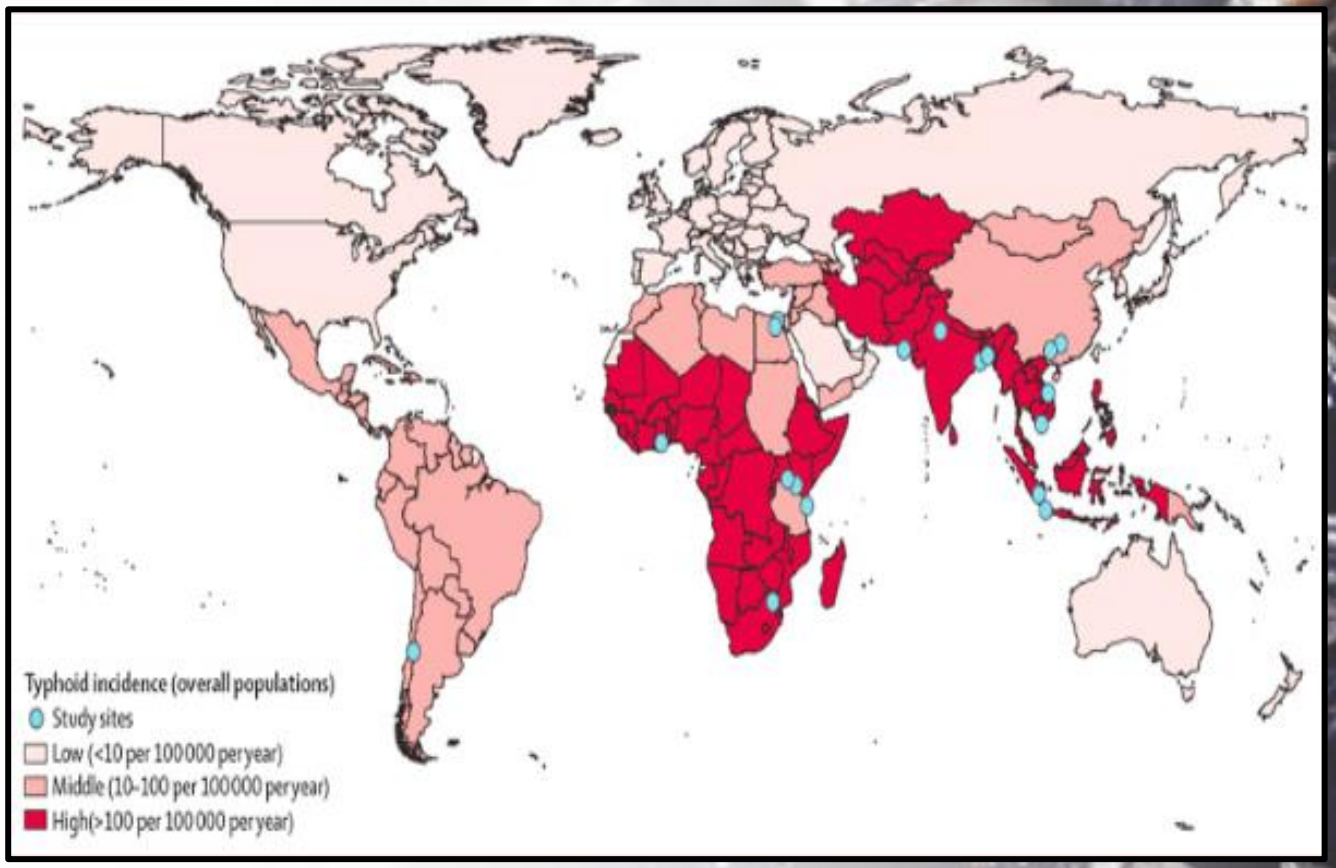
Shellfish-related pathogens in Asia Pacific

- All major shellfish-related pathogens found in the Asian and Pacific general population
- Many reports of pathogen detection in shellfish samples
- Significant reports of shellfish-related outbreaks



Salmonella spp.

High incidence of typhoid fever in parts of Asia Pacific



Salmonella spp.

Salmonella regularly detected in surveys of shellfish in Asia Pacific – outbreaks have been reported occasionally

Journal of Applied Microbiology ISSN 1364-5072

ORIGINAL ARTICLE

Distribution and genotypic characterization of *Salmonella* serovars isolated from tropical seafood of Cochin, India

R. Kumar[1], P.K. Surendran[2] and N. Thampuran[1]

1 Microbiology, Fermentation and Biotechnology Division, Central Institute of Fisheries Technology, Cochin, India
2 Poothuvallil, Dr. Surendran Lane, Perumpadappu, Cochin, India

Food Microbiology, 1995, 12, 3–8

ORIGINAL ARTICLE

Prevalence of *Salmonella* in raw and cooked foods in Malaysia

R. K. Arumugaswamy,† G. Rusul,[1]* S. N. Abdul Hamid[1] and C. T. Cheah[2]

Southeast Asian J Trop Med Public Health. 1981 Mar;12(1):55-62.

An outbreak of paratyphoid A in Singapore: clinical and epidemiological studies

K T Goh

PMID: 6789457

Abstract

The epidemiological and clinical findings of 61 cases of laboratory-confirmed paratyphoid A reported in an outbreak in 1979 were described. Epidemiological investigations of 42 indigenous cases implicated imported fresh oysters as the vehicles of transmission (p less than 0.01). Although S. paratyphi A could not isolated from the implicated oysters, several observations presented tend to support the association between oyster consumption and illness. The clinical features were similar to typhoid, 82.8% of the organisms were isolated from blood cultures. The relapse rate was 8.6%. There were three stool and one urinary convalescent carriers. Two of the stool carriers were treated with cholecystectomy.

APPLIED AND ENVIRONMENTAL MICROBIOLOGY, Nov. 2007, p. 6885–6890 Vol. 73, No. 21
0099-2240/07/$08.00+0 doi:10.1128/AEM.00972-07

Detection of *Salmonella* spp. in Retail Raw Food Samples from Vietnam and Characterization of Their Antibiotic Resistance▽

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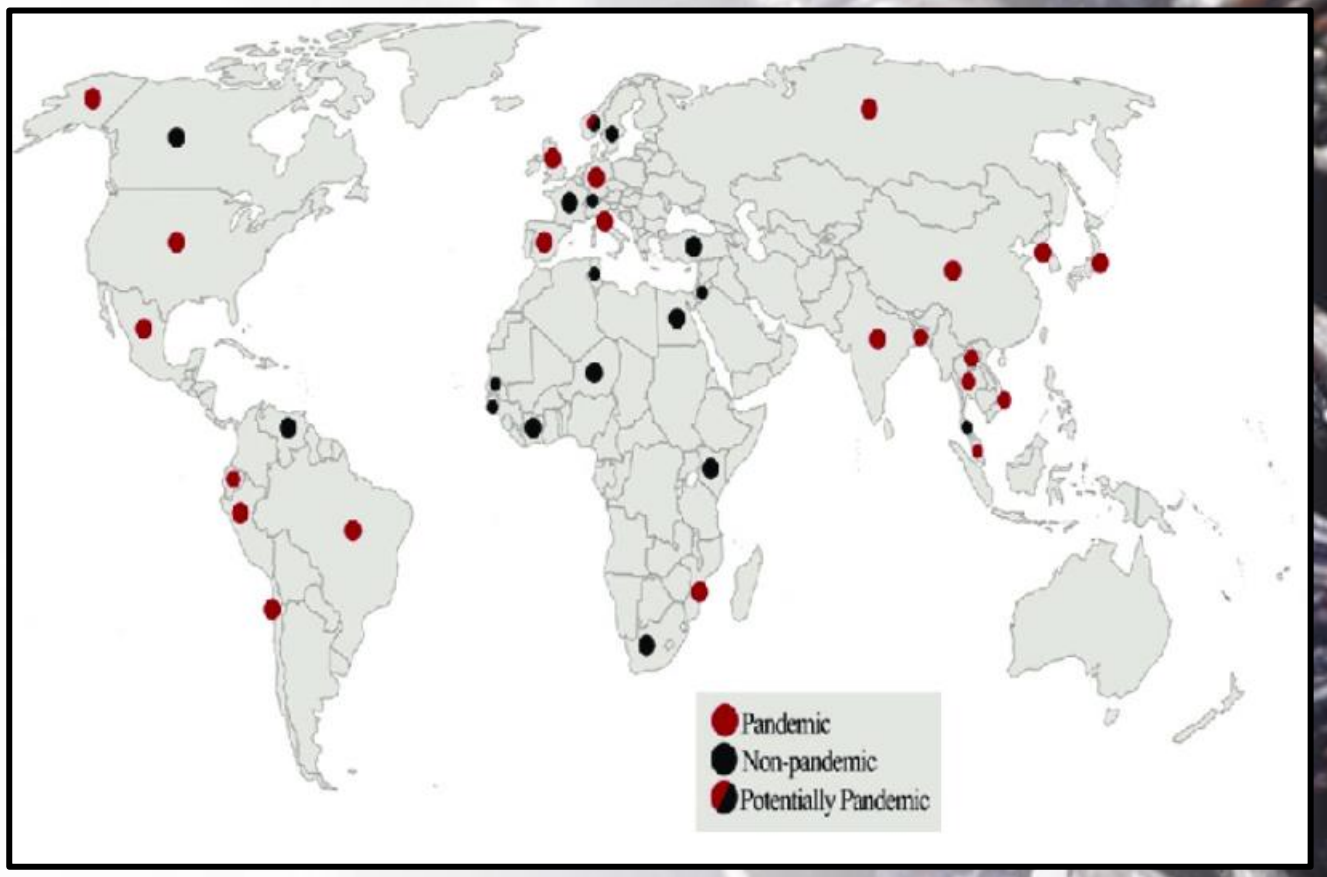
Biotechnology and Environmental Biology, School of Applied Sciences, RMIT University, Bundoora West Campus, Bundoora, Melbourne, Victoria 3083, Australia,[1] and Faculty of Biology, University of Natural Sciences, VNU-HCMC, Ho Chi Minh City, Vietnam[2]

Received 30 April 2007/Accepted 19 August 2007

Vibrio spp.

Vibrio parahaemolyticus recorded in many Asian countries (including pathogenic strains)



Vibrio spp.

Many reports of detection of *Vibrio* spp. in shellfish and of shellfish-related strains in Asia Pacific

Epidemiol. Infect. (2004), **132**, 993–996. © 2004 Cambridge University Press
DOI: 10.1017/S0950268804002407 Printed in the United Kingdom

SHORT REPORT

Vibrio vulnificus septicaemia in Japan: an estimated number of infections and physicians' knowledge of the syndrome

K. OSAKA[1*], M. KOMATSUZAKI[2,3], H. TAKAHASHI[1], S. SAKANO[4] AND N. OKABE[1]

[1] *Infectious Disease Surveillance Centre, National Institute of Infectious Diseases, Tokyo 162-8640, Japan*
[2] *Field Epidemiology Training Program, National Institute of Infectious Diseases, Tokyo 162-8640, Japan*
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[4] *Department of Public Health, School of Medicine, Hirosaki University, Hirosaki 036-8562, Japan*

(*Accepted 12 March 2004*)

JOURNAL OF CLINICAL MICROBIOLOGY, Dec. 1997, p. 3150–3155 Vol. 35, No. 12
0095-1137/97/$04.00+0

Emergence of a Unique O3:K6 Clone of *Vibrio parahaemolyticus* in Calcutta, India, and Isolation of Strains from the Same Clonal Group from Southeast Asian Travelers Arriving in Japan

JUN OKUDA,[1] MASANORI ISHIBASHI,[2] ERIKO HAYAKAWA,[3] TAKESHI NISHINO,[3] YOSHIFUMI TAKEDA,[4] ASISH K. MUKHOPADHYAY,[5] SURABHI GARG,[5] S. K. BHATTACHARYA,[5] G. BALAKRISH NAIR,[5] AND MITSUAKI NISHIBUCHI[1]*

Center for Southeast Asian Studies, Kyoto University, Yoshida, Sakyo-ku, Kyoto,[1] Osaka Prefectural Institute of Public Health, Higashinari-ku, Osaka,[2] Department of Microbiology, Kyoto Pharmaceutical University, Yamashina, Kyoto,[3] and Research Institute, International Medical Center of Japan, Shinjuku-ku, Tokyo 162,[4] Japan, and Department of Microbiology, National Institute of Cholera and Enteric Diseases, Calcutta 700 010, India[5]

Received 14 July 1997/Returned for modification 28 August 1997/Accepted 24 September 1997

Tropical Medicine and Health Vol. 41 No. 3, 2013, pp. 95-102
doi:10.2149/tmh.2011-06

Original article

Contamination by *Vibrio parahaemolyticus* and Its Virulent Strains in Seafood Marketed in Thailand, Vietnam, Malaysia, and Indonesia

Yoshitsugu Nakaguchi

Received 24 November, 2011 Accepted 19 April, 2012 Published online 19 June, 2013

Vibrio parahaemolyticus, Southern Coastal Region of China, 2007–2012

Yinghui Li, Xu Xie, Xiaolu Shi, Yiman Lin, Yaqun Qiu, Jin Mou, Qiongcheng Chen, Yan Lu, Li Zhou, Min Jiang, Honghu Sun, Hanwu Ma, Jinquan Cheng, and Qinghua Hu

We analyzed the prevalence and characteristics of *Vibrio parahaemolyticus* among patients with acute infectious diarrhea in the southern coastal region of China. *V. parahaemolyticus* was the leading cause of bacterial infectious diarrhea in this region during 2007–2012. Serotype O3:K6 strains were most common, followed by serotypes O4:K8 and O3:K29.

Norovirus

Norovirus a common cause of gastroenteritis in Asia Pacific

Journal of Medical Virology

Genetic Characterization of Norovirus Strains in Hospitalized Children From Pakistan

Amna Alam,[1]* Sohail A. Qureshi,[2] Jan Vinjé,[3] and Anita Zaidi[1,4]
[1]Department of Pediatrics and Child Health, The Aga Khan University Hospital, Karachi, Pakistan
[2]Department of Biology, Syed Babar Ali School of Science and Engineering, Lahore University of Management Sciences, Lahore, Pakistan
[3]Division of Viral Diseases, Centers for Disease Control and Prevention (CDC), Atlanta, Georgia
[4]Enteric and Diarrheal Diseases, Global Health, Bill and Melinda Gates Foundation, North Seattle, Washington

Hindawi Publishing Corporation
Journal of Tropical Medicine
Volume 2016, Article ID 2707121, 8 pages
http://dx.doi.org/10.1155/2016/2707121

Research Article

Molecular Epidemiology and Genetic Diversity of Norovirus in Young Children in Phnom Penh, Cambodia

Kaewkanya Nakjarung,[1] Ladaporn Bodhidatta,[1] Pimmnapar Neesanant,[1] Paphavee Lertsethtakarn,[1] Orntipa Sethabutr,[1] Ket Vansith,[2] Chhour Y. Meng,[2] Brett E. Swierczewski,[1] and Carl J. Mason[1]

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[2]National Pediatric Hospital, 100 Russian Federation Boulevard, Phnom Penh, Cambodia

Correspondence should be addressed to Ladaporn Bodhidatta; ladapornb@afrims.org

Norovirus GII.21 in Children with Diarrhea, Bhutan

Takaaki Yahiro, Sonam Wangchuk, Takeshi Wada, Chimmi Dorji, Takashi Matsumoto, Mimi Lhamo Mynak, Kunzang Pem Tshering, Akira Nishizono, Kamruddin Ahmed

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DOI: http://dx.doi.org/10.3201/eid2104.141856

Archives of Virology (2019) 164:1515–1525
https://doi.org/10.1007/s00705-019-04215-y

ORIGINAL ARTICLE

Norovirus and rotavirus infections in children less than five years of age hospitalized with acute gastroenteritis in Indonesia

Hera Nirwati[1] · Celeste M. Donato[2,3] · Yuli Mawarti[4] · Nenny S. Mulyani[5] · Aqsa Ikram[6,7] · Abu T. Aman[1] · Maikel P. Peppelenbosch[6] · Yati Soenarto[5] · Qiuwei Pan[6] · Mohamad S. Hakim[1,6]

Received: 5 March 2018 / Accepted: 18 February 2019 / Published online: 18 March 2019

Norovirus

Norovirus regularly detected in surveys of shellfish in Asia Pacific – outbreaks have been reported

NOROVIRUSES IN OYSTERS FROM LOCAL MARKETS AND OYSTER FARMS IN SOUTHERN THAILAND

Leera Kittigul, Kannika Pombubpa, Suntharee Sukonthalux, Tippawan Rattanatham and Fuangfa Utrarachkij

Department of Microbiology, Faculty of Public Health, Mahidol University, Bangkok, Thailand

Food Environ Virol. 2018 Mar;10(1):61-71. doi: 10.1007/s12560-017-9325-1. Epub 2017 Nov 7.

Oyster Contamination with Human Noroviruses Impacted by Urban Drainage and Seasonal Flooding in Vietnam

Gia Thanh Nguyen [1 2 3], Jian Pu [4], Takayuki Miura [5], Hiroaki Ito [6], Shinobu Kazama [7], Yoshimitsu Konta [8], An Van Le [9], Toru Watanabe [10]

PMID: 29230695 DOI: 10.1007/s12560-017-9325-1

Epidemiol. Infect. (2016), **144**, 2759–2764. © Cambridge University Press 2016
doi:10.1017/S0950268816000170

An outbreak of norovirus infection associated with fermented oyster consumption in South Korea, 2013

H. G. CHO[1], S. G. LEE[2], M. Y. LEE[3], E. S. HUR[1], J. S. LEE[4], P. H. PARK[1], Y. B. PARK[1], M. H. YOON[1] AND S. Y. PAIK[5]*

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[2] *Korea Zoonosis Research Institute, Chonbuk National University, Iksan, Republic of Korea*
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Received 31 August 2015; Final revision 16 November 2015; Accepted 14 January 2016; first published online 2 February 2016

European Journal of Epidemiology **15**: 175–180, 1999.

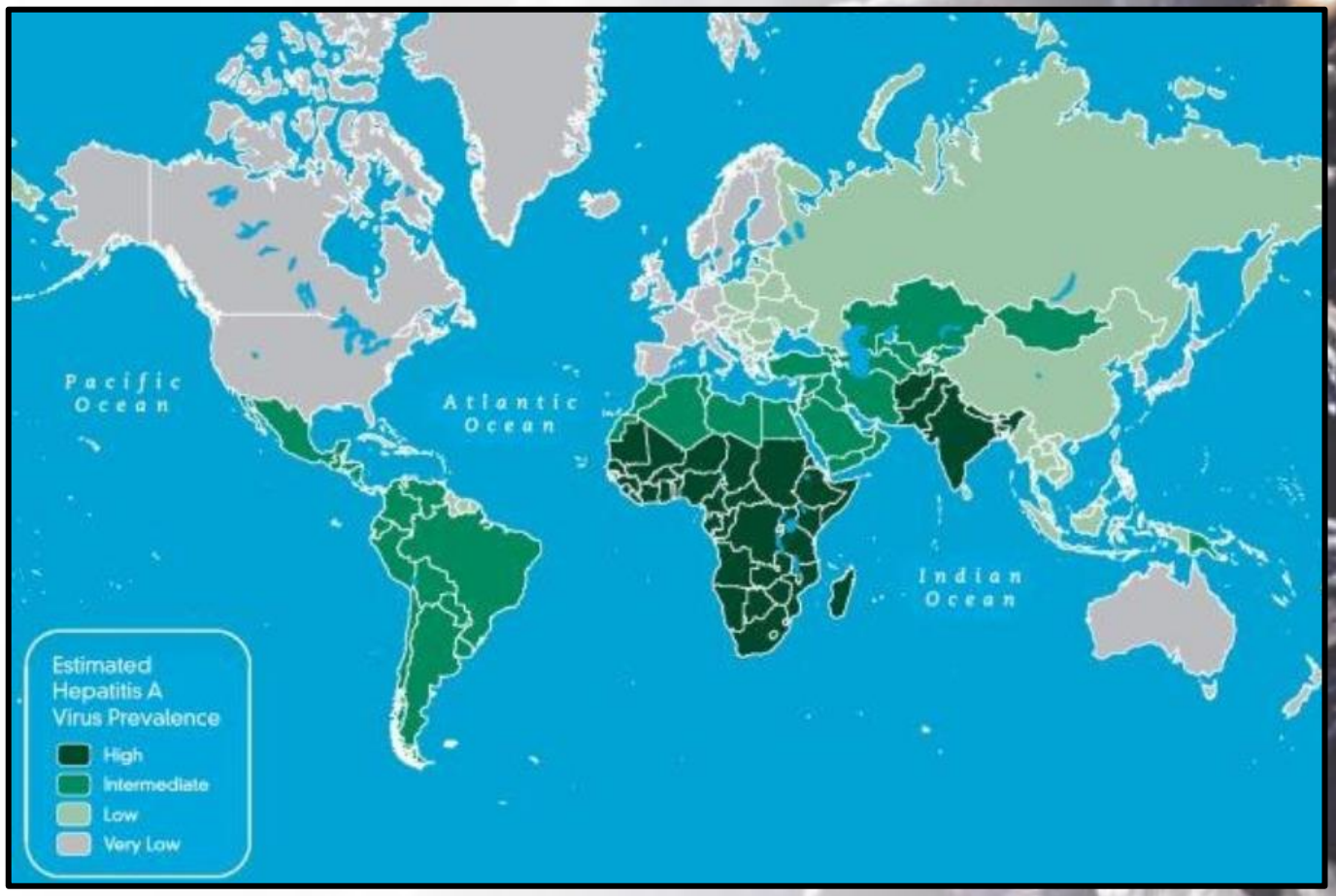
Outbreaks of gastroenteritis caused by SRSVs from 1987 to 1992 in Kyushu, Japan: Four outbreaks associated with oyster consumption

Ryuichi Otsu
Fukuoka Institute of Health and Environmental Sciences, Mukaizano, Dazaifu, Fukuoka, Japan

Accepted in revised form 23 October 1998

Hepatitis A virus

High/intermediate prevalence of HAV in some parts of Asia Pacific



Hepatitis A virus

HAV regularly detected in surveys of shellfish in Asia Pacific – outbreaks have been reported

Letters in Applied Microbiology

Letters in Applied Microbiology ISSN 0266-8254

ORIGINAL ARTICLE

Surveillance of hepatitis A and E viruses contamination in shellfish in Thailand

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1 Department of Microbiology, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand
2 Fishery Technological Development Division, Bangkok, Thailand
3 Research Collaboration Center on Emerging and Re-emerging Infections (RCC-ERI), Department of Medical Sciences, Nonthaburi, Thailand
4 Central Government, Department of Fisheries, Bangkok, Thailand
5 Department of Virology, Armed Forces Research Institute of Medical Sciences, Bangkok, Thailand
6 Fish Inspection and Quality Control Division, Surat Thani, Thailand

Bulletin of the World Health Organization, 62 (6): 893 – 897 (1984)

An epidemic of cockles-associated hepatitis A in Singapore

K. T. Goh,[1] L. Chan,[2] J. L. Ding,[2] & C. J. Oon[3]

An epidemic of serologically confirmed hepatitis A occurred between May and September 1983 in Singapore. The vehicle of transmission was traced to raw and partially cooked cockles, Anadara granosa, *which had been imported from places with no sanitary control on the production. Strict controls on imported cockles are warranted.*

Epidemiol. Infect. (2000), **124**, 121–130. Printed in the United Kingdom

Hepatitis A in New South Wales, Australia, from consumption of oysters: the first reported outbreak

S. CONATY[1], P. BIRD[2], G. BELL[3], E. KRAA[4], G. GROHMANN[5] AND J. M. McANULTY[1]*

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[2] *Hunter Public Health Unit, NSW, Australia*
[3] *Northern Districts Public Health Unit, NSW, Australia*
[4] *Food and Nutrition Branch, NSW Health Department, NSW, Australia*
[5] *Department of Veterinary Anatomy and Pathology, University of Sydney, Australia*

(*Accepted 6 September 1999*)

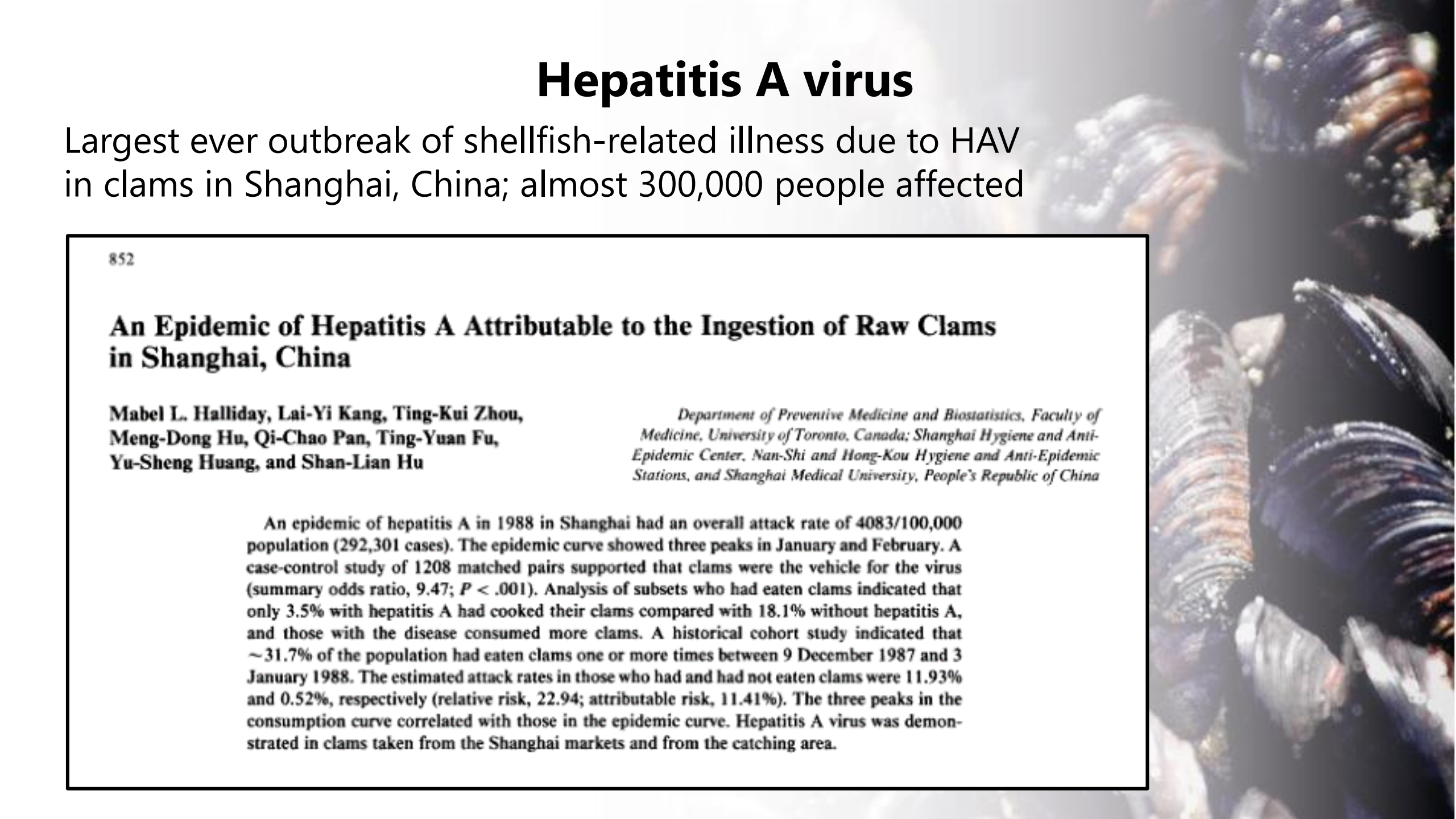
An Epidemic of Hepatitis A Attributable to the Ingestion of Raw Clams in Shanghai, China

Mabel L. Halliday, Lai-Yi Kang, Ting-Kui Zhou, Meng-Dong Hu, Qi-Chao Pan, Ting-Yuan Fu, Yu-Sheng Huang, and Shan-Lian Hu

Department of Preventive Medicine and Biostatistics, Faculty of Medicine, University of Toronto, Canada; Shanghai Hygiene and Anti-Epidemic Center, Nan-Shi and Hong-Kou Hygiene and Anti-Epidemic Stations, and Shanghai Medical University, People's Republic of China

Hepatitis A virus

Largest ever outbreak of shellfish-related illness due to HAV in clams in Shanghai, China; almost 300,000 people affected



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An Epidemic of Hepatitis A Attributable to the Ingestion of Raw Clams in Shanghai, China

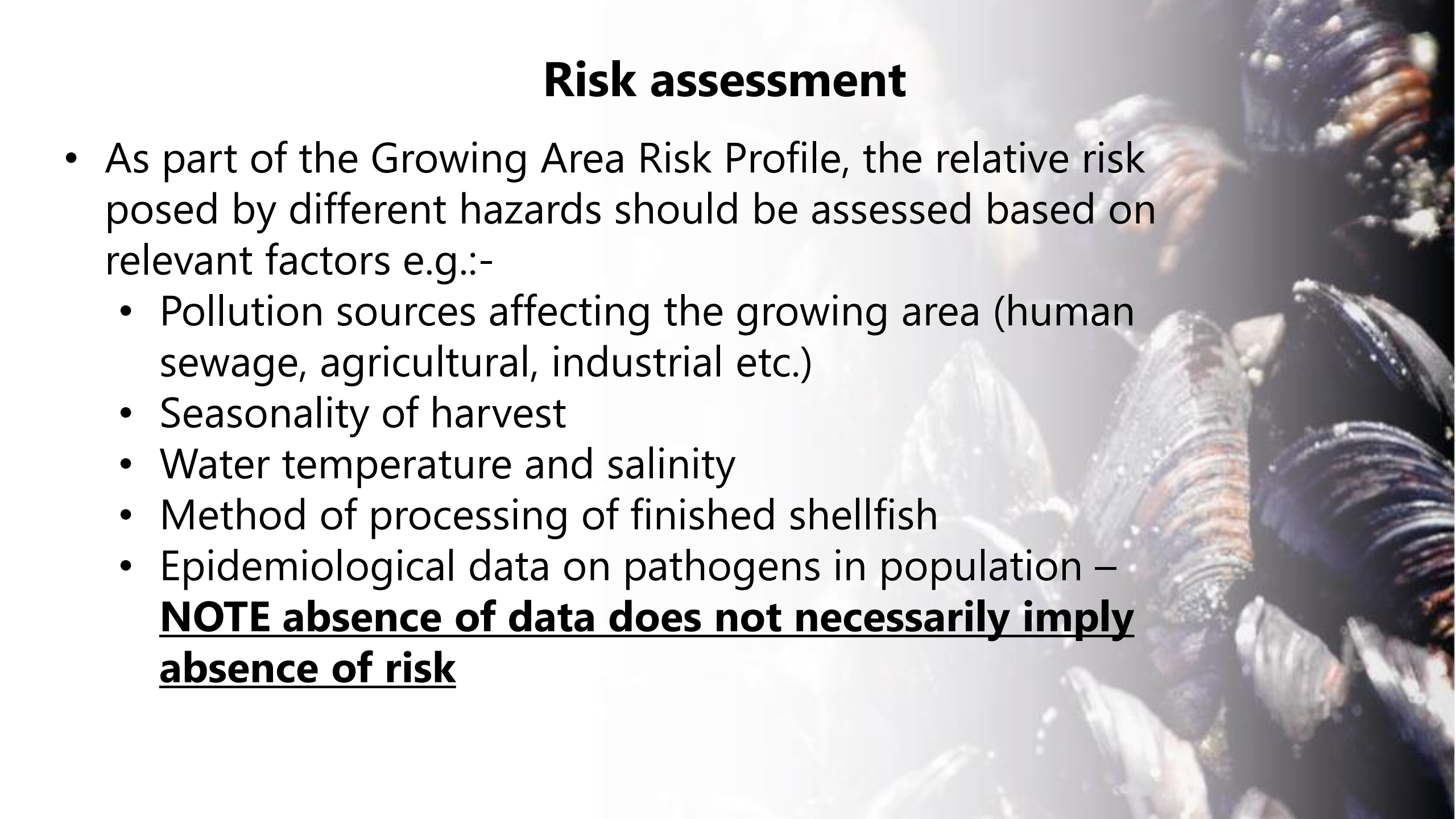
Mabel L. Halliday, Lai-Yi Kang, Ting-Kui Zhou, Meng-Dong Hu, Qi-Chao Pan, Ting-Yuan Fu, Yu-Sheng Huang, and Shan-Lian Hu

Department of Preventive Medicine and Biostatistics, Faculty of Medicine, University of Toronto, Canada; Shanghai Hygiene and Anti-Epidemic Center, Nan-Shi and Hong-Kou Hygiene and Anti-Epidemic Stations, and Shanghai Medical University, People's Republic of China

An epidemic of hepatitis A in 1988 in Shanghai had an overall attack rate of 4083/100,000 population (292,301 cases). The epidemic curve showed three peaks in January and February. A case-control study of 1208 matched pairs supported that clams were the vehicle for the virus (summary odds ratio, 9.47; $P < .001$). Analysis of subsets who had eaten clams indicated that only 3.5% with hepatitis A had cooked their clams compared with 18.1% without hepatitis A, and those with the disease consumed more clams. A historical cohort study indicated that ~31.7% of the population had eaten clams one or more times between 9 December 1987 and 3 January 1988. The estimated attack rates in those who had and had not eaten clams were 11.93% and 0.52%, respectively (relative risk, 22.94; attributable risk, 11.41%). The three peaks in the consumption curve correlated with those in the epidemic curve. Hepatitis A virus was demonstrated in clams taken from the Shanghai markets and from the catching area.

Risk assessment

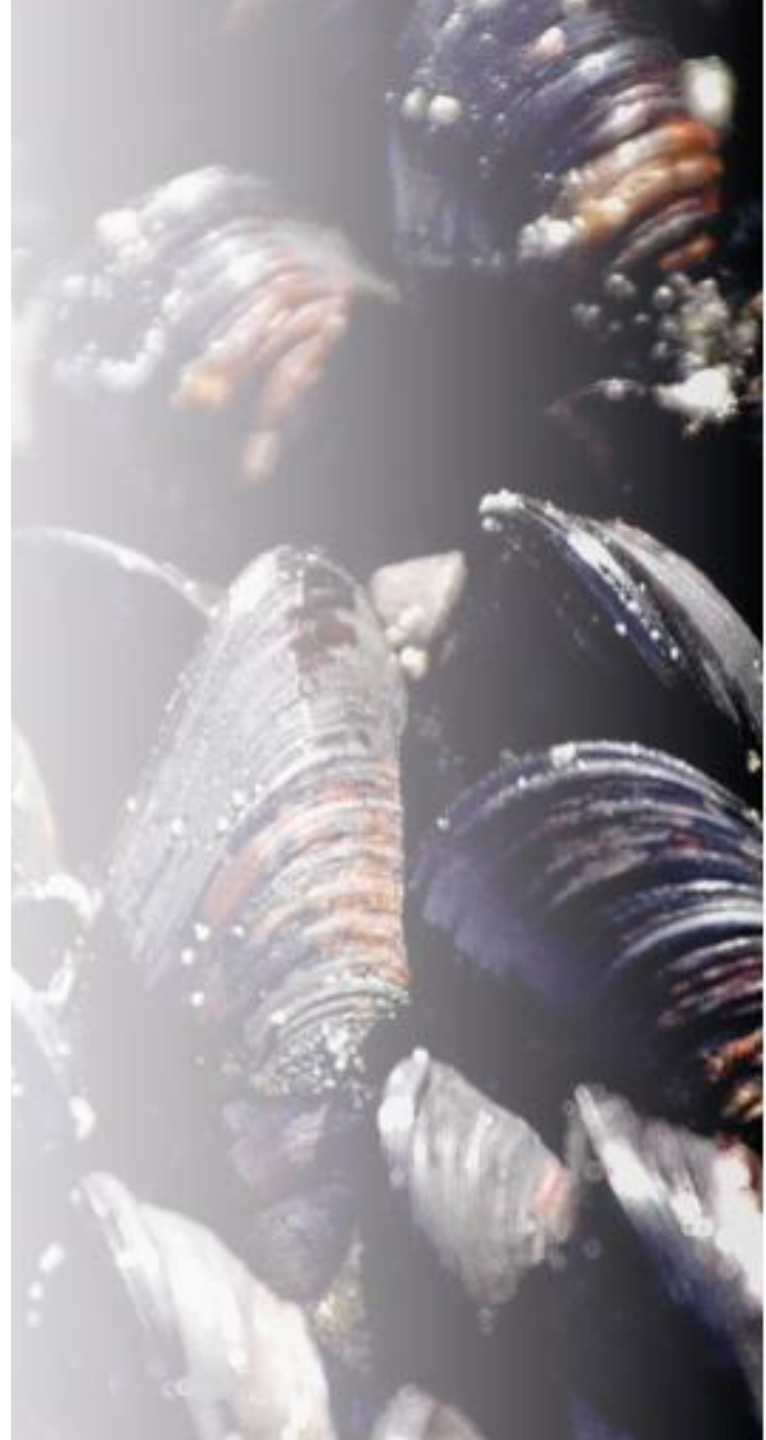
- As part of the Growing Area Risk Profile, the relative risk posed by different hazards should be assessed based on relevant factors e.g.:-
  - Pollution sources affecting the growing area (human sewage, agricultural, industrial etc.)
  - Seasonality of harvest
  - Water temperature and salinity
  - Method of processing of finished shellfish
  - Epidemiological data on pathogens in population – **NOTE absence of data does not necessarily imply absence of risk**



PRINCIPAL SOURCE AND FACTOR CONSIDERATIONS FOR THE MAJOR HAZARD GROUPS

HUMAN ENTERIC PATHOGENS	ANIMAL ENTERIC PATHOGENS	MARINE VIBRIOS	BIOTOXINS	CHEMICAL CONTAMINANTS
Continous sewage discharges	Farm animal polpulations	Concentration of potentially pathogennic species	Occurrence of potentially toxic phytoplankton	Industrial effluents
Intermittent sewage discharges	Animal waste storage locations	Proportion of pathogenic strains	Occurrence of biotoxins in bivalves	Landfill sites
Private sewage discharges	Slurry spreading locations	Seawater temperature	Seawater temperature	Mining
Direct defecation to land	Terrestrial wild animal populations	Seawater salinity	Seawater salinity	Shipping & boating
Sewage sludge spreading	Marine wild animal populations			Marine waste disposal sites
Rainfall-dependent discharges (or run-off)	Wild bird populations			Geological sources
Shipping & boating	Rainfall mediated run-off			Contaminated sediments

Hydrography

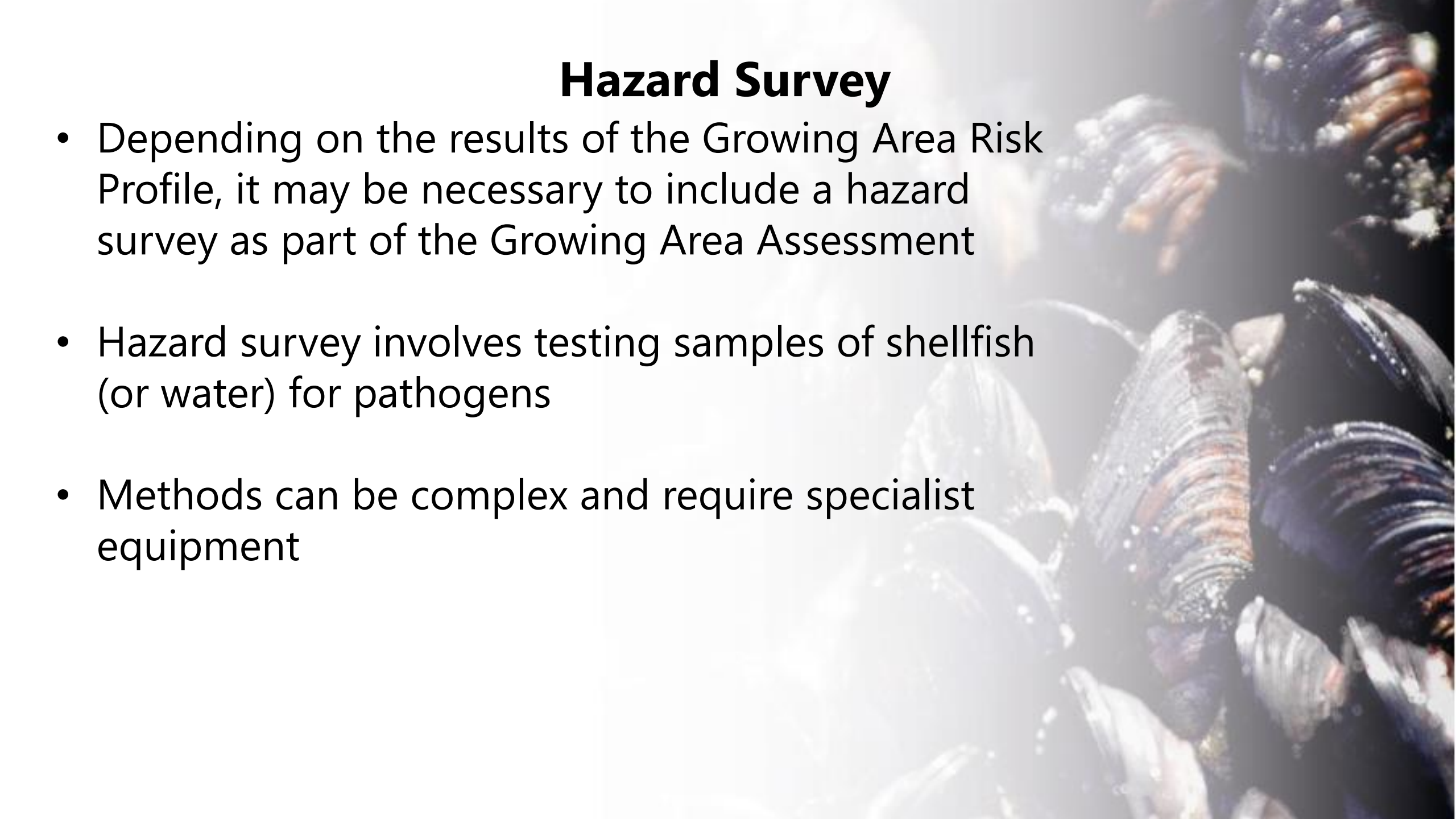


Hazard Survey

- Depending on the results of the Growing Area Risk Profile, it may be necessary to include a hazard survey as part of the Growing Area Assessment

- Hazard survey involves testing samples of shellfish (or water) for pathogens

- Methods can be complex and require specialist equipment



Methods

Norovirus and Hepatitis A virus	**ISO 15216-1**	**Quantification using real-time RT-PCR**
***Salmonella* spp.**	**ISO 6579-1**	**Detection by growth on selective bacteriological media – confirmation using biochemical/serological tests**
***Vibrio* spp.**	**ISO 21872-1**	**Detection by growth on selective bacteriological media – confirmation using biochemical/PCR tests**

Method for Norovirus and Hepatitis A virus (ISO 15216-1)

- Multi-stage procedure including a comprehensive suite of controls
- Digestive tissues dissected from the shellfish, then virus extracted using a digestion with Proteinase K solution
- Viral RNA purified from digested sample using guanidine isothiocyanate to denature virus proteins and magnetic silica beads as RNA-binding matrix
- Detection of target viruses using TaqMan real-time RT-PCR (one-step) with virus-specific primer and probe sequences
- Negative and positive controls, standard curves for quantification and controls for extraction efficiency and RT-PCR inhibition included

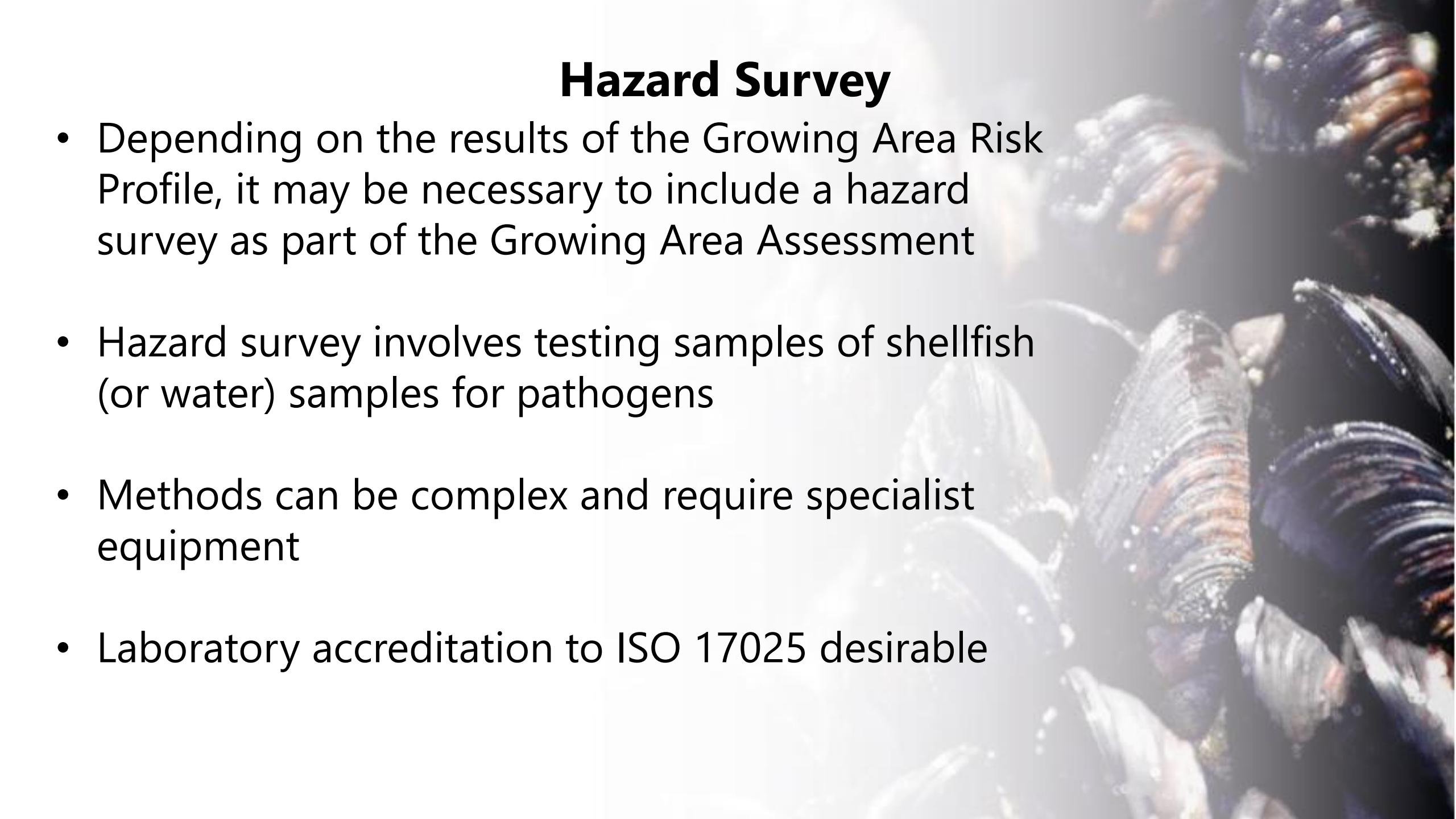
Hazard Survey

- Depending on the results of the Growing Area Risk Profile, it may be necessary to include a hazard survey as part of the Growing Area Assessment

- Hazard survey involves testing samples of shellfish (or water) samples for pathogens

- Methods can be complex and require specialist equipment

- Laboratory accreditation to ISO 17025 desirable



Summary

- Wide variety of chemical, biotoxin and microbiological hazards associated with shellfish consumption
- Microbiological hazards include bacteria (*Salmonella, Vibrio*), viruses (norovirus, hepatitis A virus), parasites
- Risks posed by different hazards may depend on the characteristics of the growing area
- Specific testing for hazards may require specialist laboratories