Objection	
Objector:	Mr. Allan J Navratil
Organisation Name:	East Cork Harbour for a Safe Environment
Objector Address:	Ballinacurra Hse.,, Midleton, Midleton, Co. Cork.
Objection Title:	Objection #OS006014 - 3rd party objection for Reg No:[P1103-01]
Objection Reference No.:	OS006014
Objection Received:	18 March 2020
Objector Type:	3rd Party
Oral Hearing Requested?	No
Application	
Applicant:	Dairygold Co-Operative Society Ltd and TINE Ireland Ltd
Reg. No.:	P1103-01
See below for Objection details. Attachments are displayed on the following page(s).	

East Cork Harbour for a Safe Environment

Dr. Darina Allen, Martin Edwardes BSc. Roma Fulton BSc., Michael Harty, Joan Hayes MA.,
AJ Navratil BSc., Anna O'Connor, Anne Marie Russell, William Russell & others

in Alliance with Climate Aware Midleton & FH Wetland Systems Ltd.

Tel: 021-461-3555

Please reply to;
AJ Navratil, ajnavratil@eircom.net
Ballinacurra House,
Midleton, P25 AH30
County Cork.

The Secretary,
Environmental Protection Agency,
Johnstown Castle,
Y35 W821
County Wexford
www.epa.ie

17-3-2020

Re: Proposed EPA licence No. Ref: P1103-01

Dear Sir/Madam,

The following are the objections, submissions and representations to the proposed determination of an industrial emissions licence application by Dairygold Co-Op Society Ltd and Tine Ireland Ltd., for an installation at Mogeely and an outfall to Cork Harbour on behalf of all those named above.

Preamble:

1 In the context of the multiple submissions regarding the above proposal by Dairygold-Tine to the Planning Authority of the Cork County Council since late 2016 and subsequently the quality and detail of the submissions to the EPA it is difficult to find any lawful justification for how both organisations could have created the current improper and unacceptable situation.

2 It is a matter of particularly significance and public knowledge that Irish Water are now the Water Services Authority (not the CCC as stated on page 10 of the proposed licence) and understood to have advised the applicants and the CCC that the cheese effluent should be conveyed by long pipe and then joined into the Midleton sewerage system. For such methodology to be lawful and correct, however, it has to be fully compliant with all relevant aspects of the EU Habitats Directive. Please see References [not exhaustive] in this document.

We are not satisfied that this DIRECTIVE has been fully complied with and that nothing is left to peradventure.

3 It should be clearly understood by all concerned that the said Habitats Directive is what it says it is in the title. It is a "DIRECTIVE". A directive is an imperative. It is not a suggestion or any sort of option. A directive requires full compliance with all aspects thereto and therefore *beyond all doubt* to validate a Planning Consent. Absent such total compliance any Planning Permission or licence is ill-founded and null and void and thereby unlawful. As this group have never been afforded sight or evidence of the requisite 100% compliance accordingly absent such unequivocal evidence it is reasonable to adduce that the actions taken and the Planning Permission and proposed licence are not compliant and thus may indeed be unlawful and legally unsafe.

4 For the absolute avoidance of doubt you are referred to the Habitats Directive (92/43/EEC) Article 6(3)

"3 . Any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to Appropriate Assessment of its implications for the site in view of the site's conservation objectives. In the light of the conclusions of the assessment of the implications for the site and subject to the provisions of paragraph 4 , the competent national authorities shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned ***and , if appropriate, after having obtained the opinion of the general public." ECHSA believe that, in that context, the rights of the general public have been and are being compromised.***

* The test for Appropriate Assessment is not as the report suggests but is explicitly stated by Finlay Geoghegan J. in Kelly v An Bord Pleanala (2014) IEHC 400 25-7-2014. qv.

* Please also note that Irish and EU court rulings were as follows:

The Irish High Court Judge cited various European Court of Justice (ECJ) rulings in s.35,

"The ECJ has considered what is required by an "appropriate assessment" in a number of judgments. In Mechanical Cockle Fishing case (Case C-127/02 Waddenzee), the ECJ stated that an "appropriate assessment" implies that ***ALL*** *the aspects of the plan or project which can, by themselves* ***or in combination*** *with other plans or projects, affect the site's conservation objectives must be identified in the light of the best scientific knowledge in the field. In Case C 404/09 Commission v. Spain, the ECJ held that an assessment cannot be regarded as "appropriate" if it contains gaps and lacks complete, precise and definitive findings and conclusions* ***capable of removing all reasonable scientific doubt as to the effects of the proposed works on the site concerned****.* NB: This requirement has been restated in more recent judgments, including Case C 258/11 Sweetman, [44] and Case C 521/12 Briels".

In the Case C-258/11, quoted here, the judgement was similar:

"44. So far as concerns the assessment carried out under Article 6(3) of the Habitats Directive, it should be pointed out that ***it cannot have lacunae and must contain complete, precise and definitive findings and conclusions capable of removing all reasonable scientific doubt as to the effects of the works proposed on the protected site concerned.****"*

It is manifestly clear that Dairygold or the relevant authorities have NOT made the case to address our concerns which, pursuant to the EU Directive as supported by court Judgements, require ***complete, precise and definitive findings and conclusions capable of removing all reasonable scientific doubt.***

Accordingly, notwithstanding the assertion in the text of the draft licence on page 12 that an Appropriate Assessment was undertaken ECHSA herewith formally question the conclusion of that alleged AA and therefore demur from paragraph 6 (inter alia) on page 12 of the proposed draft EPA licence **with most particular reference to Paralytic Shellfish Poisoning (PSP). Please see contextual extracts from publications under "References" below.**

The following should be well noted that in the considered view of ECHSE and its advisors;

- Compliance with the European Communities Environmental Objectives (Surface Waters) Regulations 2009 (S.I No 272 of 2009), [as amended] is not the same as removing all reasonable scientific doubt.
- It is incorrect to state in the Proposed Determination (PD) that Monitoring will ensure the emissions from the site will not negatively impact on the environment and will ensure the protection of human health. That is manifestly absurd. **Monitoring will not ensure anything of the sort**.
- The Proposed Determination (PD) requires that all storm waters exceeding trigger levels will be diverted for retention and suitable disposal certainly does not remove all reasonable scientific doubt.
- Best Available Techniques in no way removes all reasonable scientific doubt.
- The Office of Environmental Enforcement (OEE) is responsible for the enforcement of EPA licences issued to industry and is committed to taking action against those who flout the law but not orders of the High Court.

5 Plainly stated; **It is simply not good enough that the 'cart was put before the horse'** as Planning Consent was given to build a factory and a long outfall pipe **before** all technical details submissions and objections were properly considered or even could be considered at all and now the EPA propose to grant a licence without full, clear, proper and total regard to;

a. the relevant EU Directives referred to above including court judgements evidencing unlawful non-compliance in respect of water pollution et al.

b. The Irish States obligations to reduce National pollution in compliance with relevant EU Directives. (qv)

c. the fact that neither the Applicant nor the Planning Authority or Irish Water or the EPA have NOT proven to the degree demanded by the Habitats Directive that they have been given *complete, precise and definitive findings and conclusions* ***capable of removing all reasonable scientific doubt*** about our concerns (the public) as legally required by the Directive.

d. all the realities cogently articulated and contained in the submissions, representations and objections made and the holistic impact on the Irish economy with particular regard to Irelands accepted legal obligations in the context of reduction of Greenhouse gases etc., and pollutants.

e. Scientifically grounded and clearly stated opposition to the degradation of the waters of Cork Harbour including, inter alia, the impact of the proposed additional nutrient and organic loading on the harbour in the particular context of **the potential to render shellfish actually toxic to mammalian consumption,** tourism and amenity in the harbour.
Caveat: When critical levels of nutrients such as N&P are reached algal blooms can and do result which in turn cause Dinoflagellates that exist in the North Channel and the Owenacurra River to cause toxins to be produced which are concentrated by filter feeders such as mussels and oysters. The consumption of such contaminated organisms by humans can lead to rapid paralysis, heart failure and even death.

f. As the proposed discharge is of the order of 4,000 m_3 or 4,000 tons of water per day ECHSA have yet to see positive evidence of the effect of this and thus is concerned that the hydrological and or phreatic considerations have been holistically and properly addressed in particular context of (in no particular order);

1. the river at Mogeely and the wildlife therein,
2. the local segment of the biosphere (i.e. future farm crops) and
3 the future integrity of adjacent buildings
4 any other relevant aspect.

g. and, more recently, the Objections of An Taisce, *The National Trust For Ireland*, dated the 6th of march 2020 under the following principal headings;

I. Overarching Considerations.
II. Bovine Agricultural Impacts.

III. Failure of Proposed determination to assess use of resources and direct, indirect and cumulative impact.
IV. Information deficiencies in the environmental impact assessment report and Natura impact statement.
V. The Pipeline discharge issue.
VI. The site suitability issue.
VII. Appendices numbered 1,2,3,4& 5.

In summary:

It is clear that the Planning Consent was given for the construction of a plant which included a long pipe for minimally treated effluent **before** all technical details submissions and objections were properly considered or even could be considered at all and now the EPA propose to grant a licence without full, clear, proper and total regard to EU Directives, extant court Judgements and the increased risk of Paralytic Shellfish Poisoning (PSP) and the legal obligation for the removal of all scientific doubt etc., was prejudicial to proper development.

That conduct it seems;

(i) pre-supposed that the EPA, notwithstanding any and all objections and representation by the residents of the Harbour area and scientifically qualified concerned parties, would automatically grant a licence for discharge as originally proposed by the applicant investors or

(ii) passed the burden on to the EPA to impose further and better conditions.

Both such 'back to front' outcomes can clearly be described as deeply unfair to the community and profoundly prejudicial to proper planning.

General: Any decisions that may have been grounded on prejudice and/or cavalier disregard for the fundamentals would be manifestly wrong and in justice if excused would remain wrong. In all events, the individuals involved in and also the relevant authorities themselves, if culpable of untenable procedures, will be held fully accountable.
As so many fundamentals and alternatives have been overlooked or seemingly even ignored by Cork County Council, Irish Water and now the EPA in arriving at, de facto, incongruent conclusions it raises the query as to what part of the word "Directive" the various parties seem unable to understand? The intended decision seems to ECHSA to at least call to question the authenticity, validity, methodology and indeed conduct leading to all the decisions reached by all these bodies in this specific Dairygold-Tine application also the various consents may well have incurred the risk of the creation of a stranded asset with all that that implies including relevant accountability.

Conclusion:

East Cork Harbour for a Safe Environment and all Allied groups or persons as per this letter heading accordingly are left with no alternative but to seek that all matters surrounding the Planning Consents and licences as given be re-visited We request and require that all necessary corrections and rescissions are duly made and in accordance with all the matters raised. We would expect no less of an august body such as the EPA to objectively and methodically re-visit all and every one of the considerations systematically and all reservations as articulated above and per attached references. It is a ***sine qua non*** that that is the duty and function of the EPA to ensure full compliance who should note that no underperformance whatsoever will be accepted by the Objectors named herein.

ECHSA and the Allied groups named in this objection would support, in due course, whatever challenge may be lawfully required and permitted involving the Applicants, Irish Water, CCC and the EPA *et al* in our opposition to the granting of a discharge licence as proposed.

Yours faithfully,

Chairman ECHSA E&OE

Allied objections include the following:

Climate Aware Midleton & FH Wetland Systems Ltd., as per memos below

Climate Aware Midleton

Objection to the proposed determination to Dairygold Co- Operative Society Ltd and TINE Ireland Ltd License application registration number P1103-01

16th March 2020

I am making an objection on behalf of the group *Climate Aware Midleton*. Many of our members are people of East Ferry and as a member of the broader East Cork around Midleton town. We object to the granting of this wastewater license in the strongest possible terms.

We object to the proposal on the grounds that Dairygold's Natura Impact Statement (NIS) is seriously flawed. In the NIS it is claimed that water in the area of Cork Harbour where the discharge will end up will undergo an 80% exchange rate on the ebb tide. There is no basis or source given in the NIS for this highly optimistic figure. The figure is used to argue that no significant risk exists to the habitats and protected species of the Great Channel Island Special Area of Conservation (SAC) and Cork Harbour Special Protected Area (SPA). This claim is directly contradicted by an independent report completed by Irish Hydrodata Ltd. for Irish Water, which drew on earlier research. The much lower exchange

value, identified in this research, indicates a risk of mixing and accumulation of pollution resulting from the discharge proposal.

Dairygold's NIS says that "there will be no significant elevation in nutrient or BOD concentrations owing to the proposed WWTP discharges" were made before the Irish Hyrodata Ltd. report was included in it. Therefore this part of the NIS does not stand up to scrutiny. Indeed, there appears to be no contrary evidence proffered to establish the NIS claim, prior to this other research coming to light.

There is a lack of detailed consideration in the NIS of where released effluent will end up in the restricted space of Cork Harbour. A 2012 study by NUIG researchers (Hartnett at al.) shows that residence times of waters in Cork Harbour can be over 60 days; in the region of the Rathcoursey outflow and the East Ferry channel it is around 50 days.

European legislation mandates appropriate assessment of conversation sites (the Cork Harbour Special Protected Area and the Great Island Channel Special Area of Conservation). The documents submitted by Dairygold to date represent stage 1 (screening) and stage 2 (NIS) of such an assessment process. As the NIS has not shown that adverse impacts on protected wildlife can be ruled out, Dairygold is obliged to proceed to stage 3 (assessment of alternative solutions). The standard that must be reached by Dairygold according to EU directives on the protection of species and habitats is that "no reasonable scientific doubt as to the absence of such effects".

Alternatives to the current waste discharge proposal were requested by Cork Co. Council at an earlier stage in the planning process. Dairygold's response to this request contained no analysis of alternatives. I wrote to Dairygold in June 2019 asking for details on alternative waste water plans they have considered and received a general paragraph on their commitment to environmental standards but no answer to that question.

Accordingly, due to the serious flaws in Dairygold's Natura Impact Statement and the contrary evidence from independent sources that protected species and water quality would be at significant risk from their waste discharge, as well as Dairygold's lack of consideration of alternative waste discharge plans, we object strongly to Dairygold's proposal. As such as do not believe that the waste water discharge license can ethically be granted by the EPA. Climate Aware Midleton, as well as our fellow neighbours and friends in East Cork, Midleton and the broader Cork Harbour area, request an oral hearing on Dairygold and TINE license application.

Yours truly, Roisin Cuddihy

Roisin Cuddihy on behalf of *Climate Aware Midleton*
21 Blossom Hill,
Broomfield East, Midleton, Co.Cork.

FH WETLAND SYSTEMS Ltd.

30 Woodlawn, Lahinch Rd., Ennis, Co. Clare, V95 A8D3. Tel: 065 6797355
www.wetlandsystems.ie e-mail: reeds@wetlandsystems.ie

Input on joint objection to the EPA from "Climate Aware Midleton" and "East Cork Harbour for a Safe Environment" 14 March 2020

Re. Alternative disposal options for Dairygold/TINE discharge at Rathcoursey Point.

This submission is made for a more complete appraisal of options for high quality treatment on site and discharge to adjacent waterways rather than piping to Cork Harbour. With over 20 years of experience working with constructed wetlands, reed beds and other natural treatment systems it is my opinion that high quality effluent treatment on site is a viable alternative to the proposed 14km pipe to Rathcoursey Point.

The size of a constructed wetland system need not be overly arduous. If the majority of treatment is carried out by a standard mechanical aeration unit with additional phosphate removal, a constructed wetland system of *c.*5.5ha would be sufficient to provide tertiary polishing of effluent prior to discharge into the river at the site.

Another option worthy of greater consideration is to irrigate a willow crop using the effluent. Willows are well known for their usefulness in mopping up liquid, nitrates and phosphates and have been used in Denmark over the past 20 years for sewage treatment applications. If Dairygold were to utilise the effluent as a nutrient source for a biomass crop this would eliminate any pollution source and would create a viable crop for sale. Bord na Mona are looking for biomass to augment their co-firing plant in Edenderry and elsewhere. This will become more important in coming years as Moneypoint either closes or converts from coal to biomass, helping to guarantee a market.

The land area that could be irrigated with willows is *c.*385ha, based on previous experience with zero discharge willow systems in Ireland. Diversification of land use will become increasingly important in Ireland as CAP reform puts ever greater pressure on our farmers to become more financially viable with ever more limited subsidies.

Conversely if the aim is to dispose of the effluent rather than irrigation per se, then discharge via percolation through a willow filter system may also be a viable option. An area of 22-170ha (depending on infiltration rates) would be suitable, as long as the effluent was treated to a suitable standard prior to the willow system. This would also provide nutrient uptake, and a biomass willow crop. Recent forestry grants for short rotation coppice plantation establishment would offset implementation costs. Flooding in the area may reduce the effectiveness of the percolation treatment on an occasional basis, but for the majority of the time, this would not be an issue, and the dilution rates would be high enough during a flood event to offset the reduced soil treatment.

Please do not hesitate to call or email with any questions on any of the above information.

Yours sincerely, Féidhlim Harty

Directors: F. Harty, Dr. E Hitching *Co. Reg. No.* 383998 *VAT No.* IE 6403998I

References include the following:

European Commission
Environment DG
Methodological guidance on the provisions of
Article 6(3) and (4) of the Habitats Directive 92/43/EEC
November 2001
Impacts Assessment Unit, School of Planning, Oxford Brookes University, Gipsy Lane Headington, Oxford OX3 0BP, United Kingdom. Tel. (44-1865) 48 34 34
E-mail: wjweston@brookes.ac.uk

and

Guidance document on Article 6(4) of the
'Habitats Directive' 92/43/EEC
CLARIFICATION OF THE CONCEPTS OF: *ALTERNATIVE SOLUTIONS, IMPERATIVE*
REASONS OF OVERRIDING PUBLIC INTEREST, COMPENSATORY MEASURES, OVERALL COHERENCE, OPINION OF THE COMMISSION. 2007/2012
This guidance document should be read in conjunction with the booklet published by the European Commission in 2000 and entitled "Managing Natura 2000 sites. The provisions of Article 6 of the 'Habitats' Directive 92/43/EEC". The current document intends to further develop and replace the section on Article 6(4) of this earlier publication leaflet.

FH Wetland Systems Ltd., Submission dated 14th March 2020 as below.

Paralytic Shellfish Poisoning

Paralytic shellfish poisoning (PSP) is a worldwide problem caused by consumption of shellfish that have accumulated potent neurotoxins produced by toxicogenic dinoflagellates.
From: Encyclopedia of Separation Science, 2000

Venoms and Poisons from Marine Organisms

Jay W. Fox, in Goldman's Cecil Medicine (Twenty Fourth Edition), 2012
Saxitoxin and Gonyautoxin

Paralytic *shellfish poisoning* is typically associated with the ingestion of mussels, clams, and oysters. The two toxins associated with this poisoning, saxitoxin and gonyautoxin, are produced by marine microalgae dinoflagellates that are associated with harmful algal blooms, such as "red tides," and are then accumulated in bivalve shellfish to give rise to "paralytic" shellfish

poisoning. The primary paralytic shellfish poisoning toxins are heterocyclic compounds that block nerve and muscle action potentials by binding to sodium channels at the same site as tetrodotoxin, thereby resulting in paralysis.

Paralytic shellfish poisoning, which is significantly more severe than neurotoxic shellfish poisoning, predominantly involves neurologic symptoms with less pronounced nausea, vomiting, or diarrhea. Symptoms appear soon after the consumption of contaminated shellfish (minutes to hours), beginning with circumoral and extremity paresthesias. Additional neurologic symptoms such as ataxia, arthralgia, dysphagia, dysmetria, diaphoresis, and tachycardia soon follow the initial paresthesias. Respiratory depression or failure can result in death, usually within 12 hours of the onset of symptoms. As with other shellfish poisoning, therapy is supportive, with close attention to potential respiratory distress or failure.

Seafood Poisoning

Vernon Ansdell, in Travel Medicine (Fourth Edition), 2019

Paralytic Shellfish Poisoning

Paralytic shellfish poisoning (PSP) has been recognized for over 200 years. The first documented outbreak in travelers was in 1793 and was reported in Captain George Vancouver's *A Voyage of Discovery to the North Pacific Ocean and Round the World*. On June 15, 1793, during his exploration of British Columbia, Vancouver described in his diary classic cases of PSP in five crew members who had eaten locally harvested mussels for breakfast. One of the crew members, John Carter, died 5.5 hours later. The others survived. Vancouver subsequently named the area where the mussels were harvested Poison Cove.

PSP is the most common and most serious form of shellfish poisoning and occurs after eating contaminated bivalve mollusks (clams, cockles, mussels, oysters, and scallops), crustaceans (Dungeness crabs, shrimp, and lobsters) containing saxitoxin, and other potent neurotoxins produced by dinoflagellates (e.g., *Alexandrium* sp.). Saxitoxin, like CTX and tetrodotoxin, causes paralysis by blocking sodium channels in nerve cell membranes. It is 50 times more potent than curare. Saxitoxin and other toxins that cause PSP are heat stable and are not destroyed by normal cooking procedures, marinating, or freezing.

As in other forms of shellfish poisoning, outbreaks of PSP often follow dinoflagellate blooms. In the past, most cases of PSP occurred in cold, temperate waters above latitude 30° north and below latitude 30° south. Recently, however, outbreaks in tropical and subtropical waters have become more frequent, with cases reported from countries such as Guatemala, El Salvador, Mexico, Thailand, Singapore, Malaysia, Papua New Guinea, India, and the Solomon Islands.

Because the main toxins that produce pufferfish poisoning (tetrodotoxin) and PSP (saxitoxin) are very similar, the clinical effects are almost indistinguishable. Symptoms of PSP usually occur within 30–60 minutes of eating toxic shellfish but can be delayed for 3 hours or longer. Early symptoms include paresthesias of the face, lips, and tongue, and later the arms and legs. Affected

persons may complain of lightheadedness or a floating sensation. Other symptoms may include headache, increased salivation, nausea, vomiting, and diarrhea. Hypertension may be an important finding. Severe cases are usually associated with ingestion of large doses of toxin and clinical features, such as ataxia, dysphagia, and mental status changes. Flaccid paralysis occurs in the most severe cases, with respiratory insufficiency as a result of paralysis of the diaphragm and chest wall muscles. Deaths are typically caused by respiratory failure and tend to occur within 12 hours of eating toxic shellfish. For patients who survive past 12 hours, the prognosis is good. Recovery usually occurs within a week but may occasionally be prolonged for several weeks.[32,33]

Case fatality rate averages 6% but may be as high as 44%. Mortality is higher in children, who seem to be particularly sensitive to the effects of the toxin. Travelers to low- and middle-income countries who are tempted to eat shellfish should be reminded that the highest mortality from PSP occurs in areas with poor access to good-quality medical care.

Diagnosis is usually made on clinical grounds, although in special circumstances it can be confirmed by a standard mouse bioassay method.

There are no antidotes for PSP, but saxitoxin and other toxins that cause PSP bind well to charcoal and, if safe, oral charcoal should be given. Sufferers should be observed for at least 24 hours for respiratory insufficiency. Mechanical ventilation may be necessary.

PSP can be prevented by avoiding potentially contaminated shellfish. This is particularly important in children, who are at greater risk of fatal illness. It is important to emphasize that the presence of the toxin does not affect the appearance, smell, or taste of the shellfish, and cooking will not destroy the toxin. Because of the lack of sophisticated medical facilities for resuscitation and mechanical ventilation, it is prudent for all travelers to developing countries to completely avoid potentially toxic shellfish.

Synthesizing Organism

Paralytic Shellfish Poisoning

Dinoflagellates in Australian waters that can synthesize the toxins to cause paralytic shellfish poisoning (PSP) include members of the genera *Alexandrium* (*Gonyaulax*), *Gymnodinium*, and *Pyrodinium*. A number of toxigenic species of *Alexandrium* are found in New Zealand waters.

Neurotoxic Shellfish Poisoning

Neurotoxic shellfish poisoning (NSP) in New Zealand has been caused by brevetoxin synthesis by an organism similar to *Gymnodinium breve* (*Ptychodiscus brevis*), which is the organism responsible for NSP in the Gulf of Mexico. Similar organisms have been found in Australian waters. Compounds similar to brevetoxin can also be synthesized by some other marine algae found in Australian waters.

Diarrhetic Shellfish Poisoning

Potentially toxic diarrhetic shellfish poisoning (DSP) dinoflagellates in Australian waters include species of the genera *Dinophysis* and *Prorocentrum*. The toxicity of these species is variable, and sometimes dense blooms occur with no toxin synthesis. DSP is relatively rare in New Zealand.

Amnestic Shellfish Poisoning

The toxin responsible for amnestic shellfish poisoning, domoic acid, is synthesized by diatoms of the genus *Pseudo-nitzschia*.

Fish and Shellfish Poisoning

Elaine C. Jong, in The Travel and Tropical Medicine Manual (Fifth Edition), 2017

Paralytic Shellfish Poisoning

An unusual neurologic disorder that may follow shellfish ingestion is termed paralytic shellfish poisoning. The disease is primarily associated with the consumption of bivalve mollusks, such as clams, mussels, and oysters, but has also been reported following ingestion of gastropods, chitons, starfish, and crustaceans. Crab, abalone, and fin fish do not appear to be affected. The disease is mainly restricted to temperate climates, with most reported outbreaks in North America, Europe, and Japan, although cases have also occurred in South Africa, Papua New Guinea, and New Zealand.

The toxicity of paralytic shellfish poisoning is due to the accumulation of saxitoxin, a tetrahydropurine base, and related compounds in the shellfish. It does not affect the appearance or taste of the marine mollusks, nor is it effectively inactivated by cooking. Like tetrodotoxin, it blocks action potential generation by preventing sodium ion flow in nerve and muscle cell membranes.

Saxitoxin originates in a unicellular dinoflagellate known as *Gonyaulax*. Since bivalve mollusks are filter feeders, they concentrate the toxins from *Gonyaulax* in their digestive glands (the hepatopancreas). In the Alaska butter clam (*Saxidomus*), the saxitoxin is concentrated in the siphon as well. Toxicity of shellfish correlates with the bloom of this dinoflagellate, known colloquially as "red tide" due to discoloration of coastal waters. Along the Pacific Coast these usually occur between May and October. Toxicity lessens as the dinoflagellate population decreases, but complete detoxification of shellfish may take up to a year.

Symptoms usually occur within 30 minutes after ingestion of contaminated shellfish and include distal and oral paresthesias that may progress to numbness. A sensation of "floating," gross incoordination, and paralysis with respiratory compromise may develop. The case fatality rate is 8.5%.

Diagnosis is clinical, and treatment is supportive, as with other fish poisonings. Suspect shellfish can be analyzed in a mouse bioassay. Toxic shellfish have more than 4□MU (mouse unit)/g wet flesh (1□MU of saxitoxin is the amount that kills a 20-g mouse 15 minutes following intraperitoneal injection of a heated acid extract of the shellfish). Increasing application of liquid chromatography-mass spectrometry methods for the detection of marine biotoxins in seafood safety and surveillance programs will allow for faster analysis of toxic samples.

Prevention of paralytic shellfish poisoning requires public health measures, with routine surveillance and prompt closure of any beach to shellfish collecting when toxic levels of saxitoxin are detected. A Shellfish Safety Hotline (1-800-562-5632) gives information 24 hours a day on harmful algal blooms on Pacific Ocean beaches in Washington state; Oregon maintains its own hotline (1-800-449-2474).

Cardiovascular Toxicity from Marine Envenomation

Benjamin Seymour, ... Jamie Seymour, in Heart and Toxins, 2015

Saxitoxin

Saxitoxin (STX) and its derivatives cause a poisoning commonly referred to as paralytic shellfish poisoning and paralytic pufferfish poisoning following bioaccumulation and ingestion. The toxins are produced in the marine environment by groups of dinoflagellates, namely *Alexandrium* spp., *Gymnodium* spp., and *Pyrodinium* spp.[1,2] A number of different bioaccumulation pathways have been shown, with typical vectors including bivalves and pufferfish and extending into atypical hosts (e.g., crustaceans, gastropods, a number of fish species, and a significant number of marine mammals and birds).

The structure of saxitoxin, like most phycotoxins, is relatively complex (Figure 7.1) and has several different derivatives.[1] Saxitoxin toxicity is mediated through its effects on the Na^+, K^+, and Ca^{2+} channels. The primary target of saxitoxin has long been established as the Na^+ channel where it binds externally to receptor site 1 to halt inward Na^+ flow while also acting as a cationic substitute. In vitro saxitoxin has been shown to modify K^+ channel gating causing retardation of opening and activation while increasing the deactivation rate and subsequently resulting in decreased ion transmission through the channel.[3] Further, in vitro studies have demonstrated saxitoxins' effect on L-type Ca^{2+} channels where the toxin caused a channel blockade with a maximal effect of 49%, suggesting a mechanism other than a simple pore block as seen in Na^+ channels; as yet, this remains to be fully elucidated.[4]