

Food poisoning due to the consumption of red whelks (*Neptunea antiqua*)

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SUMMARY

Two incidents of toxin-type food poisoning in N.E. Scotland associated with the consumption of red whelks (*Neptunea antiqua*) are described.

Four patients developed symptoms within 1 h of consuming whole whelks. These included visual disturbances – double vision and difficulty in focusing – tingling of the fingers, prostration and in one subject nausea, vomiting, diarrhoea and ataxia. In all cases recovery was complete in 24 h. Using a newly developed analytical technique the concentration of the causative toxin, tetramine, in the salivary glands of the whelks consumed was estimated at 0.07%, equivalent to a content of 3.75 mg/100 g of the shellfish.

INTRODUCTION

Documented incidents of food poisoning following consumption of gastropods from Northern European waters are rare. However, in 1970 a case of poisoning in Fife was reported as being due to consumption of the gastropod *Neptunea antiqua* (red whelk) (Fleming, 1971). Following that incident, it was shown by Ayres & Wood (1973) that extracts of the salivary gland of the red whelk (equivalent to 0.15 mg of tissue) were toxic to mice. This work confirmed earlier studies by Fange (1957) in Norway.

The toxin had previously been shown by a Japanese worker (Asano, 1952) to be present in the salivary gland of the related species *N. arthritica* and to be tetramethyl ammonium hydroxide (tetramine) (Asano & Ito, 1959).

There are few suitable analytical procedures available for the determination of tetramine. In the previous Japanese and Norwegian studies paper-chromatographic and thin-layer chromatographic (TLC) procedures had been used to separate tetramine from other quaternary ammonium compounds. A TLC procedure was used by Japanese workers as recently as 1986 (Kungsuwan *et al.* 1986). In our hands this method was not found to be satisfactory, there being a tendency for the tetramine to streak in the recommended solvents, making both resolution and quantification of quaternary ammonium compounds difficult. High-voltage electrophoresis on paper has been shown to give superior resolution and has been used in this study.

In this report two incidents of toxin-type food poisoning associated with the consumption of whole red whelks are described, together with an assay for the causative toxin tetramine based on high-voltage paper electrophoresis.

PATIENTS AND METHODS

Incident 1

In early April 1986 a 32-year-old man, weight 56 kg, developed ataxia, tingling of the fingers and double vision within 30 min of eating the whole flesh of four large (12–15 cm) whelks, followed by nausea, vomiting, diarrhoea and prostration. The symptoms subsided after 6 h and recovery was complete by the next day.

Incident 2

One week later a family of three, father, mother and daughter, were initially affected by visual disturbances – double vision and inability to focus commencing approximately 40 min after consuming whelks. The father, a fit 60-year-old man (weight 64 kg) consumed the most ($1\frac{1}{2}$) whelks. All were admitted to hospital for overnight observation as a precautionary measure but no supportive therapy was required. None of the family developed gastrointestinal symptoms and all had made a complete recovery within 24 h. None of those affected suffered any late complications or long-term neurological sequelae.

In both incidents the whelks had been boiled, removed from their shells and baked in butter for 15–30 min prior to consumption. The shells of the whelks from both episodes measured 12–15 cm in length and were positively identified by the Department of Agriculture and Fisheries Marine Laboratory, Aberdeen as *Neptunea antiqua*. The remaining red whelks were stored frozen at -20°C prior to analysis for tetramine.

Inquiries by Environmental Health Officers indicated that the whelks in the two incidents had been purchased from reputable retail fishmongers and had originated from different ports on the N.E. coast, though the exact source could not be identified.

TETRAMINE ASSAY

Experimental procedure

The four whelks which had been received at Torry Research Station in the frozen state were allowed to thaw out at room temperature. During the thawing process the animal became detached from the shell and was readily removed by pulling on the operculum. Using a scalpel the foot was slit open and the salivary glands, two soft-tissue orange lobes at the base of the proboscis were then excised (Fig. 1). A mean weight of 1.42 g of salivary glands was obtained from a mean 30.8 g of edible flesh.

The glands from each shellfish were heated separately in 25 ml methanol under reflux for 30 min and the supernatant solutions filtered and taken to dryness in a rotary evaporator.

The residue was taken up in 0.5 ml aqueous methanol (1:1 v/v, water:methanol) and any undissolved material separated by centrifugation (11 600 g).

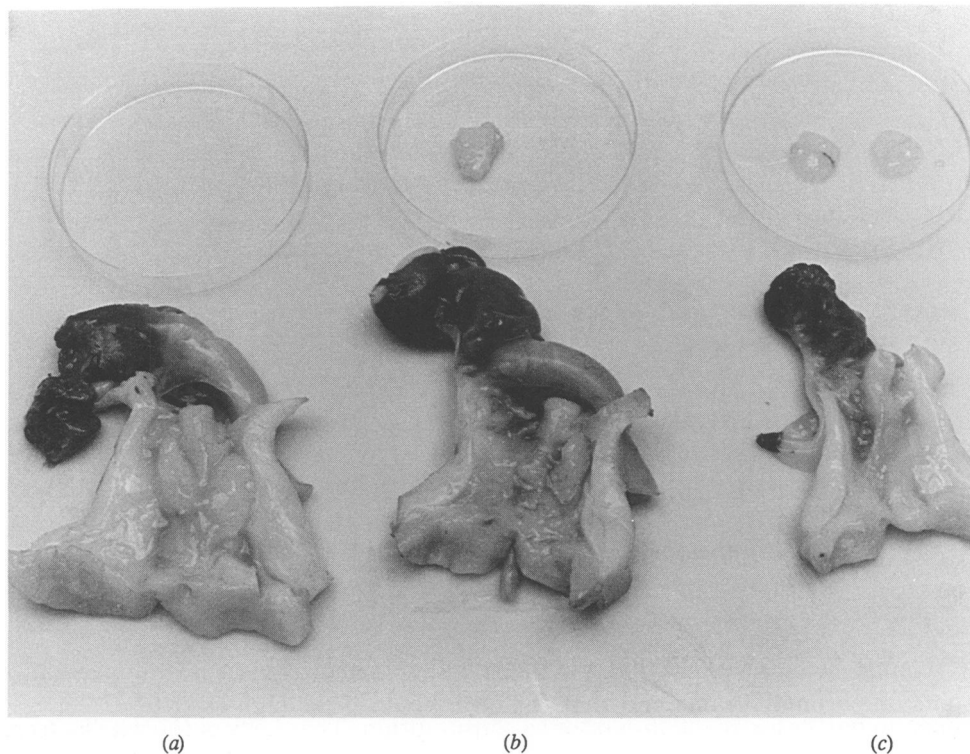


Fig. 1. *Neptunea antiqua* removed from the shell and cut open to reveal the salivary glands. (a) Both glands *in situ*, (b) one gland removed and (c) both glands removed.

High-voltage paper electrophoresis

High-voltage paper electrophoresis was carried out on Whatman 3 mm chromatography grade paper soaked in 0.1 M sodium borate buffer $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$, pH 9.0. The aqueous methanol extract of the samples was diluted $\times 2$, $\times 3$, $\times 5$ and $\times 10$ respectively, and 5 μl aliquots applied to the paper. A standard of authentic tetramine, Sigma Chemical Company Ltd. Poole, Dorset (5 μl) containing 1 mg/ml was run for comparison. Electrophoresis was carried out at 4 kV, 0.054 A for 5 min in a Locarte high-voltage electrophoresis apparatus, and after the paper was allowed to dry it was sprayed with Draggendorff's reagent (Touchstone & Dobbins, 1978). The reddish brown spots which developed were identical in colour and in mobility to that of authentic tetramine.

RESULTS

Estimation of the amount of tetramine in the shellfish

The tetramine content of the salivary glands was estimated to be 750 $\mu\text{g/g}$ (0.075%), and as the glands on average weighed between 4 and 6% of the wet weight of the shellfish flesh this is equivalent to a content of 3.75 mg/100 g of the whole meat.

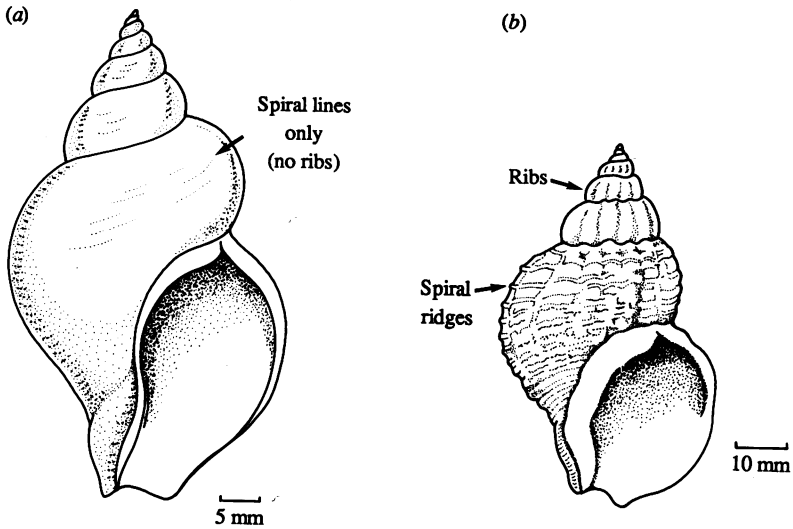


Fig. 2. (a) The red whelk (*Neptunea antiqua*) and (b) the edible whelk (*Buccinum undatum*).

It must be emphasized that the above value is made by visual comparison of spots on chromatograms and that the error could be as high as $\pm 25\%$.

DISCUSSION

Neptunea species are commonly found around the coast of northern Britain. They are not infrequently taken as part of the incidental catch or 'by-catch' of bottom trawls, and can be present in small numbers in catches of common edible whelks (*Buccinum undatum*). As such, they may be offered for sale at market stalls or fishmongers' shops. The red whelk and common edible whelk can be distinguished by examining the shell (Graham, 1971). The former is usually larger and hence is attractive to the prospective unwitting buyer. The red whelk shell has no ribs and only spiral lines, whereas the common edible whelk has sinuous ribs crossed by spiral ridges (Fig. 2).

The symptoms experienced by our patients are similar to those described by Fleming (1971) in his original paper and were dominated by curare-like effects induced by the toxin tetramine. His patient, a young man who consumed six large (13–15 cm long) red whelks equivalent to about 100 g of whole flesh, developed blurred vision, muscular twitching, tingling of the hands and feet, weakness, paralysis and collapse, but recovered in 24 h. By comparison, the young man (57 kg body weight) in incident 1 and the father (65 kg) in incident 2 probably consumed approximately 100 g and 45 g whole flesh respectively, equivalent to 2.5 mg and 1.75 mg active toxin, since approximately 30% of the activity of the toxin is lost after boiling for 15 min (Ayres & Wood, 1973).

Published values for the tetramine content of the salivary gland of the Japanese whelk *N. arthritica* are given as 0.5% (Asano & Ito, 1959) and 0.02% (Kungsuwan *et al.* 1986). These values should be compared with the 0.07% obtained by us.

Following these incidents, warning notices describing the differences between the red whelks and common edible whelks and the problems associated with consumption of the former distributed through the Environmental Health Departments concerned to fishmongers, merchants and fishermen, and a circular outlining the problem was issued by the Scottish Home and Health Department to Health Boards and Directors of Environmental Health. Since then only one further incident has been reported (Millar & Dey, 1987). This occurred in April 1987 in S.W. Scotland, when four persons became ill and suffered the characteristic visual disturbances after eating whelks purchased from a fishing boat at Ayr harbour. Further inquiry and examination of the empty shells suggested that a mixture of common and red whelks had been eaten. It appeared the skippers and fish buyers did not appreciate the differences between the two types and were unaware of the potential danger of red whelk, although they were regularly caught in west coast waters. Copies of the warning notices were distributed to skippers and buyers at Ayr Fish Market and to date no further case has been reported.

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