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BRIAN OTTWAY, MILES PARKER, DAVID MCGRATH, MICHAEL CROWLEY.

OBSERVATIONS ON A BLOOM OF *GYRODINIUM AUREOLUM* HULBERT ON THE SOUTH COAST OF IRELAND, SUMMER 1976, ASSOCIATED WITH MORTALITIES OF LITTORAL AND SUB-LITTORAL ORGANISMS.

Observations on a bloom of *Gyrodinium aureolum* Hulbert on the south coast of Ireland, summer 1976, associated with mortalities of littoral and sub-littoral organisms.

BRIAN OTTWAY[1]
MILES PARKER[2]
DAVID MCGRATH[3]
MICHAEL CROWLEY[2]

ABSTRACT

In late July and early August 1976, kills of lugworm (*Arenicola marina* (L.)) and other marine life were reported from several areas of the south coast of Ireland. These reports were investigated and further field observations made. The mortalities were associated with a bloom of the naked dinoflagellate *Gyrodinium aureolum* Hulbert. The possible origins of the bloom and its movement along the coast are discussed.

1. INTRODUCTION

In late July reports of substantial lugworm (*Arenicola marina* (L.)) mortalities on the south Wexford coast were received at the Department of Fisheries, Dublin. Further reports came from areas to the west and an investigation was undertaken.

The original reports were confirmed and further details were provided by the local residents and fishermen. This paper reports our observations at affected beaches, the results of examinations of water samples from some of the affected areas and of toxicological analyses of shellfish and of samples of affected fauna. The possible causes of the events are discussed.

The location of places discussed in the text may be found in figure 1.

2. FIELD OBSERVATIONS

Kilmore Quay

Lugworm mortalities were first noticed on the beach within the harbour at Kilmore Quay, Co. Wexford, on 24.7.1976 by local people. At the same time a brown discolouration of the water was noted, both in the harbour and in the lobster holding-tanks of the Kilmore Quay Fisherman's Co-operative.

The area was visited by two of the authors on 29.7.1976. Large numbers of lugworms were lying dead and bleached on the sand surface or in pools. Others had died halfway out of their burrows. Some live lugworms were found wriggling feebly in pools, but making no attempt to re-burrow. No live *Arenicola* were taken by digging and no casts were seen on the sand. No other dead animals were found, with the exception of a single specimen of *Nereis* sp. *Nepthys hombergi* Lamarck was abundant in the muddy sand, and re-burrowed rapidly when disturbed. Some living *Macoma balthica* (L.) were also found. *Carcinus maenus* (L.) and *Crangon crangon* (L.) occurred in pools which contained dead *Arenicola*, and showed no apparent ill effects. Extensive faunal collecting on the rocky shore to the west of the harbour showed nothing unusual.

On 31.8.1976 a number of *Arenicola* casts were present on the beach, indicating that the mortality was not complete.

Duncannon

Lugworm mortalities were first noted here on 26.7.1976. Lugworms were still dying on 28.7.1976. Practically all the lugworms on the beach seemed to have been killed.

Ballynagaul, Dungarvan

Mortalities were observed on 3.8.1976.

[1] Shellfish Research Laboratory, University College, Galway.
[2] Fisheries Research Centre, Department of Fisheries, Dublin.
[3] Department of Zoology, University College, Galway.

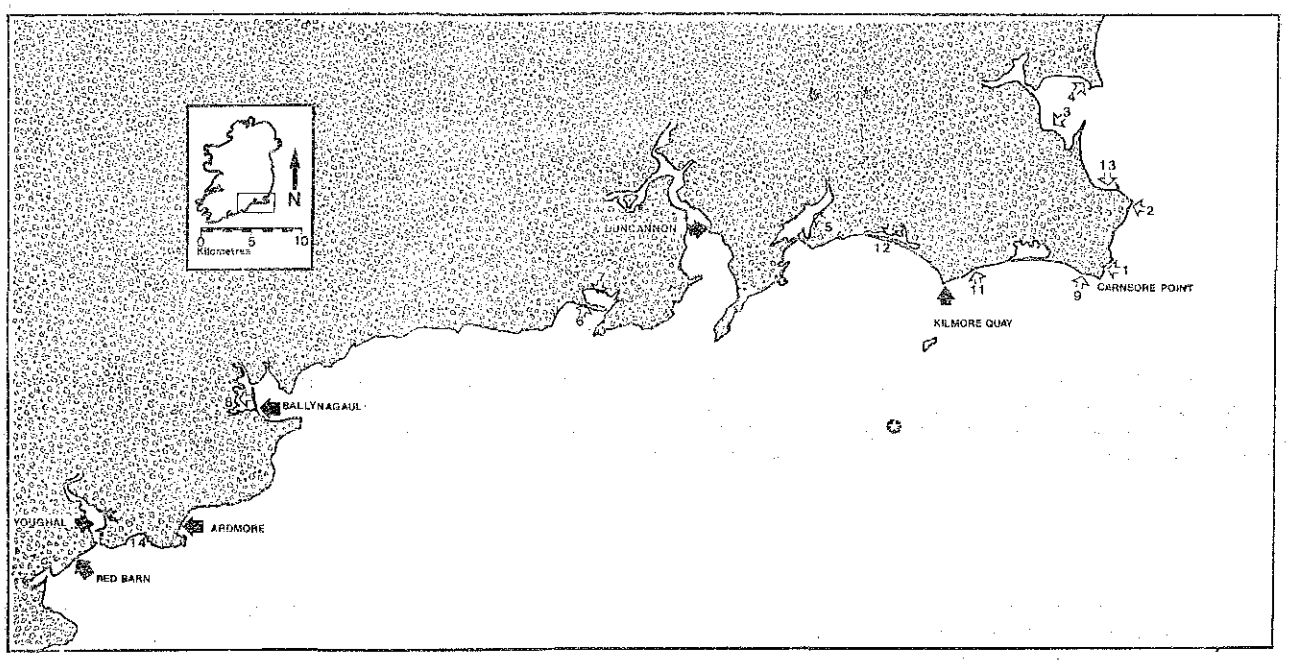

Figure 1. South-east Ireland, showing the distribution of lugworm mortalities and discoloured water (solid arrows) and beaches which were visited but found to be unaffected (open arrows). The star marks the position of the Coningbeg Light.

1 Nethertown.	5 Bannow Bay.	9 Forlorn Point.	13 Rosslare Harbour.
2 Greenore Point.	6 Tramore Beach.	10 Meanstown.	14 Whiting Bay.
3 Wexford Harbour.	7 Tramore Back Strand.	11 Ballyhealy Strand.	
4 Raven Point.	8 Inner Dungarvan Bay.	12 Ballyteigue Bay.	

Ardmore

Discolouration of the sea was observed on 3 and 4.8.1976. Lugworm mortalities occurred over a period from 4.8.1976 to at least 7.8.1976.

Youghal

This was the most westerly area to be affected, and the effects were the most dramatic. A red discolouration of the water was first noticed on 5.8.1976, which persisted until 15.8.1976 although it reduced in intensity after 10.8.1976. During this time lugworm mortalities occurred in the estuary. The worms surfaced, died, and exuded a yellow substance. The mortality was not total as casts were observed in all the usual areas shortly after 16.8.1976.

A number of other animals were affected. Over the period 6-11.8.1976, large numbers of dazed sole (*Solea* sp.), plaice (*Pleuronectes platessa* L.), flounder (*Platichthys flesus* (L.)), and sandeels (*Ammodytes* sp.) moved into shallow water off the beaches at Red Barn, Pillmore, and Clerycastle. These fish either died in the water, were stranded on the shore, or were caught by local people. Gapers (*Mya* sp.), razor shells (*Ensis* sp.), cockles (*Cerastoderma edule* (L.)) and palourdes (*Tapes decussata* L.) surfaced on the beaches and were collected. Large quantities of these fish and shellfish were removed and consumed. Perhaps coincidentally, diarrhoea was reported to be prevalent in Youghal campsites at this time.

Oxygen measurements were taken in both surface and bottom waters off the Red Barn beaches in the main channel of the estuary around mid-day on 11.8.1976. Saturation was recorded in all cases. However, these measurements were made some days after the mortalities had occurred.

Other observations

Lugworm populations were apparently unaffected on a number of beaches within the area. The following beaches on the East Coast, to the north of Carnsore Point were visited during this period—Nethertown (26-30.7.1976), Greenore Point (31.7.1976), Wexford Harbour (7.8.1976) and Raven Point (10.8.1976). All were unaffected. On the South Coast, lugworms were unaffected at:— Bannow Bay, Tramore Beach, Tramore Back Strand and inner Dungarvan Bay, between Dunmore and Ardmore. Sampling of intertidal habitats at

the following localities, some intensively examined, showed nothing unusual:— Forlorn Point (exposed rocky shore 31.7.1976). Meanstown (sandy shore, shrimp (*Crangon* sp.) taken in abundance 29.7.1976), Ballyhealy (sandy shore, 29.7.1976), Ballyteigue Bay (sandy shore, 29.7.1976) and Rosslare Harbour (31.7.1976).

Reports of poor or non-existent catches of fish at angling meetings at Ardmore (24.7.1976), Tramore (25.7.1976), and Whiting Bay, Youghal (26-28.7.1976) may have had no connection with lugworm mortalities. It is possible, given the publicity received by the kills of lugworms in the media, that undue attention was paid to these events. Weekly landings of demersal and pelagic fish and of shellfish at Dunmore East, the largest fishery centre on this coast, did not differ significantly from the average weekly landings in July and August of the previous five years.

3. CAUSATIVE AGENT

Reports of water discolouration which occurred during the mortalities suggested that an algal bloom might be responsible. Water samples were taken at the water's edge at Kilmore Quay and Ballyteigue Bay on 29.7.1976 and preserved with formalin. These samples were examined using an inverted microscope after sedimentation overnight. A list of the organisms identified is presented in Table 1.

By far the most abundant organism in the samples was a small naked dinoflagellate whose density could be estimated at approximately 500 cells/μl. (Densities of other algae in Table 1 were not estimated; however they were much less abundant than this dinoflagellate). Unfortunately, formalin is not a satisfactory preservative for these organisms. Diagnostic features were generally undistinguishable or distorted making a positive identification difficult. The species was tentatively identified as *Gyrodinium aureolum* Hulbert. The following features were noted, which are in good agreement with the description of *G. aureolum* given by Ballantine and Smith (1973):—

1) General outline, particularly the asymmetry of the lobes; prominent left hypocone and right epicone lobes.
2) Size. Mean length 21.5 μm, Mean width 18 μm.
3) Slight flattening dorso-ventrally.
4) Girdle displacement of about 0.2 times cell length.
5) Moderately deep girdle.
6) Different cross-sections of the sulcus on the epicone and hypocone.
7) Sulcus extending over the autapex.
8) Numerous small chloroplasts and highly refractive bodies.
9) Large central nucleus.

The cells are smaller than the dimensions given in the original description, 27-34 μm long $\times$ 17-32 μm wide (Hulbert, 1957). This discrepancy may be accounted for by the mode of preservation. Another possible explanation is the occurrence of smaller cells as the bloom decreases. Both of the samples were taken after the water discolouration had cleared. Ballantine and Smith (1973), noted a decrease in cell size as a bloom of *G. aureolum* died away, with the smallest cells some 29 μm long and 16 μm wide.

Other dinoflagellates were present in the samples, but at much lower cell densities (total 10/ml). *G. aureolum* is thus implicated in the mortalities at Kilmore Quay. The behaviour of *Arenicola* at the other sites would suggest that it was responsible for these events as well. The series of mortalities is very similar to those discussed by Helm *et al.* (1974) and Evans (1976, 1977) during blooms of *G. aureolum* in the eastern Irish Sea and by Boalch, Forster and Griffiths *et al.* (all 1979) during blooms off the southwest of England.

4. TOXICITY

At most sites, only lugworms were affected. At Youghal, however, mortalities of other benthic invertebrates and epibenthic fish occurred. Mobile epibenthic invertebrates do not appear to have been affected, though in Youghal there were unconfirmed reports that crabs deserted the inner estuary. This situation compares well with the report of Helm *et al.* (1974) but is in contrast to the wider mortalities described by Boalch, Forster and Griffiths *et al.* (all 1979) in southwest England.

It is not known how *G. aureolum* kills organisms. Helm *et al.* (1974) suggests that mortalities were due to oxygen depletion in the substrate caused in part by the decomposition of the dinoflagellate bloom. The behaviour of fish at Youghal is reminiscent of that described by May (1973) during the 'Jubilees' in Mobile Bay, when fish are driven ashore by in-washing de-oxygenated water. In Youghal, however, measurements (admittedly some days after the main events) showed no evidence of oxygen depletion of the water.

Another possibility is that *G. aureolum* produces an irritant which drives lugworms to the surface where they die for other reasons (e.g. exposure). The work of both Helm *et al.* (1974) and Widelows *et al.* (1979) suggests that *G. aureolum* cells are toxic to bivalves and their larvae.

Paralytic Shellfish Poisoning (P.S.P.) assays (McFarren, 1958; Ayres, pers. comm.) were carried out on mussels collected at Kilmore Quay, Tramore, Youghal, and Wexford. All tests were negative. Helm *et al.* (1974) also found no PSP toxin in mussels collected during a *G. aureolum* bloom.

5. ENVIRONMENTAL CONDITIONS AND THE DEVELOPMENT OF THE BLOOM

It is conceivable that a number of small local blooms were responsible for mortalities at individual sites. It is also possible that a single offshore bloom passing along the coast was responsible for all the incidents. The sequential chronology of events, east to west, lends support to this idea, particularly as the residual tidal drift moves westward along this coast (E. Monahan, University College, Galway, personal communication). Further, the drift west of Youghal is southward, away from the coast (Cooper, 1967). No incidents occurred west of Youghal. The sporadic nature of the incidents could be accounted for if the bloom, or moribund fractions of it were swept inshore at intervals by the tide.

Weather data from two stations in the area are available (see Table 2). Winds were mostly light, north-westerly. Rainfall was unusually low. Air temperatures were normal for the time of year (about 15°C), though the weather was somewhat overcast with little bright sunshine. Sea surface temperature records are available for the area from Coningbeg light-ship. Over the bloom period they averaged 13.0°C which is within the normal range for this time of year.

Blooms of *G. aureolum* have been reported by Pingree *et al.* (1975, 1977) associated with the thermal front which develops in the Celtic Sea during the summer. Comparable fronts occur where the stratified offshore water becomes affected by tidal mixing (Pingree *et al.* 1975). It may be conjectured that activity at this coastal tidal front could have been responsible for the development of a *Gyrodinium* bloom offshore. This bloom could then have moved westward along the coast at a speed of approximately 8 km/day. The events coincided with neap tides (20-22 July and 5-6 August), during which periods, coastal fronts may have moved shorewards.

6. PREVIOUS OCCURENCES

Gyrodinium aureolum blooms were first recorded in European waters off the Norwegian coast in 1966 (Braarud and Heimdal, 1970) and were observed to cause fish kills there in 1976 (Tangen, 1977). *G. aureolum* blooms have occurred on a number of occasions in recent years in the eastern Irish Sea (Helm *et al.*, 1974; Evans, 1976, 1977) and both inshore (Boalch, Forster, Griffiths *et al.*, all 1979) and offshore in the Celtic Sea and English Channel (Pingree *et al.*, 1975, 1977).

There have been no previous recorded instances in Irish coastal waters. During collection of information of this event, several fishermen mentioned that substantial lugworm kills had occurred before in unspecified years. Red tides are known to occur on this coast, but have not given rise to concern and no scientific investigations have been conducted.

7. CONCLUSIONS

It seems likely that lugworm and other mortalities which occurred on the South coast of Ireland during July and August of 1976 were associated with a bloom of *Gyrodinium aureolum*. This bloom appears to have developed off the Kilmore Quay area and moved westwards with the residual drift. This is the first recorded case of a bloom of *G. aureolum* in Irish coastal waters.

ACKNOWLEDGEMENTS

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REFERENCES

Balantine, D. and Smith, F. M. (1973). Observations on blooms of the dinoflagellate *Gyrodinium aureolum* Hulbert in the River Conwy and its occurrence along the North Wales Coast. *British Phycological Journal.* 8 : 233-238.

Boalch, G. T. (1979). The dinoflagellate bloom on the coast of south west England, August-September, 1979. *Journal of the Marine Biological Association of the United Kingdom.* 59 : 515-517.

Ottway, Parker, McGrath & Crowley : *Gyrodinium aureolum* bloom, south coast of Ireland 1976.

Braarud, T. and Heimdal, B. R. (1970). Brown water on the Norwegian Coast in Autumn 1966. *Nytt magasin for botanik.* 17 : 91-97.

Cooper, L. H. N. (1967). The physical oceanography of the Celtic Sea. *Oceanography and Marine Biology Annual Review.* 5 : 99-110.

Evans, D. (1976). The occurrence of *Gyrodinium aureolum* in the Eastern Irish Sea, 1975. *Scientific Report Lancashire and Western Sea Fisheries Joint Committee,* 1976.

Evans, D. (1977). Bloom algae in the eastern Irish Sea, 1976. *Scientific Report Lancashire and Western Sea Fisheries Joint Committee,* 1977.

Forster, G. R. (1979). Mortality of the bottom fauna and fish in St. Austell Bay and neighbouring areas. *Journal of the Marine Biological Association of the United Kingdom.* 59 : 517-520.

Griffiths, A. B., Dennis, R. and Potts, G. W. (1979). Mortality associated with a phytoplankton bloom off Penzance in Mounts Bay. *Journal of the Marine Biological Association of the United Kingdom.* 59 : 520-521.

Helm, M. M., Hepper, B. T., Spencer, B. E. and Walne, P. R. (1974). Lugworm mortalities and a bloom of *Gyrodinium aureolum* Hulbert in the eastern Irish Sea, Autumn 1971. *Journal of the Marine Biological Association of the United Kingdom.* 54 : 857-869.

Hulbert, E. M. (1957). The taxonomy of unarmored Dinophyceae of shallow embayments of Cape Cod, Massachusetts. *Biological Bulletin of the Marine Biological Laboratory, Woods Hole.* 112 : 196-219.

May, E. B. (1973). Extensive oxygen depletion in Mobile Bay, Alabama. *Limnology and Oceanography.* 18 : 353-366.

McFarren, E. F. (1958). Procedure for bioassay of Shellfish. *In*: *Report on Collaborative Studies of the Bioassay for Paralytic Shellfish Poison.* U.S. Department of Health, Education and Welfare.

Pingree, R. D., Pugh, P. R. Holligan, P. M. and Forster, G. R. (1975). Summer phytoplankton blooms and red tides along tidal fronts in the approaches to the English Channel. *Nature.* 265 : 266-269.

Pingree, R. D., Holligan, P. M. and Heal, R. N. (1977). Survival of dinoflagellate blooms in the eastern English Channel. *Nature.* 265 : 266-269.

Tangen, K. (1977). Blooms of *Gyrodinium aureolum* (Dinophyceae) in north European waters, accompanied by mortality in marine organisms. *Sarsia.* 63 : 123-133.

Widdows, J., Moore, M. N., Lowe, D. M. and Salkeld, P. N. (1979). Some effects of a dinoflagellate bloom (*Gyrodinium aureolum*) on the mussel *Mytilus edulis. Journal of the Marine Biological Association of the United Kingdom.* 59 : 522-524.

TABLE 1. Phytoplankton Species Lists.

(a) Kilmore Quay (surface water sample, taken at 22.30 hrs on 29.7.1976. Salinity 33.8‰).

DIATOMS

Achnanthes sp.
Asterionella bleakeleyii Wm. Smith.
Cylindrotheca closterium (Ehrenberg), Reiman & Lewin.
Fragilaria sp (F?).
Leptocylindrus minimus Gran.
Nitzschia sp.
Pleurosigma angulatum (Queckett) Wm. Smith.
Rhabdonema arcuatum (Lyngbye) Kützing.
Rhizosolenia delicatula Cleve.
Synedra sp.
Thalassionema nitzschioides Hustedt.
Centric spp. (U).
Pennate spp. (U).

DINOFLAGELLATES

Ceratium lineatum (Ehrenberg), Cleve.
Dinophysis acuminata Claparede and Lachman.
Dinophysis acuta Ehrenberg.
Gyrodinium aureolum Hulbert.
Protoperidinium brevipes, Balech.
Protoperidinium steinii (Jorgensen), Balech.
Protoperidinium sp.
Prorocentrum micans Ehrenberg.
Cysts.

OTHERS

Cosmarium sp. (F).
Oscillatoria sp. (F?).
Scenedesmus quadricauda (Turpin) (F).
Dinobryon sp. (F).
Pediastrum boryanum (Turpin) (F).
Colonial Green Alga (F?).

(b) Ballyteigue Beach (surface water sample, taken at 13.50 hrs. on 29.7.1976. Salinity 39.8‰).

DIATOMS

Amphora spp.
Asterionella bleakeleyii Wm. Smith.
Biddulphia aurita (Lyngbye) de Brébisson.
Coscinodiscus sp.
Cylindrotheca closterium (Ehrenberg), Rieman & Lewin.
Fragilaria sp. (F?).
Grammatophora marina (Lyngbye) Kützing.
Grammatophora serpentina Ehrenberg.
Leptocylindrus minimus Gran.
Licmophora sp.
Melosira moniliformis (O. F. Müller) Agardh.
Navicula monilifera Cleve.
Nitzchia sp.
Pleurosigma strigosum Wm. Smith.
Rhabdonema minutum Kutzing.
Rhizoselenia delicatula Cleve.
Synedra sp.
Thalassionema nitzschioides Hustedt.
Centric spp. (U).
Pennate spp. (U).

DINOFLAGELLATES

Ceratium lineatum (Ehrenberg), Cleve.
Dinophysis acuminata Claparede and Lachman.
Dinophysis acuta Ehrenberg.
Gyrodinium aureolum Hulbert.
Gyrodinium spirale (Bergh), Kofoid & Swezy.
Protoperidinium Steinii (Jorgensen), Balech.
Protoperidinium sp.
Procentrum micans (Ehrenberg).
Cysts.

OTHERS

Coccolithophorid (F).
Cosmarium sp. (F).
Oscillatoria sp. (F?).
Pediastrum boryanum (Turpin) (F).
Scenedesmus quadricauda (Turpin) (F).
Silicoflagellate.
Various unicellular and filamentous Blue-green Algae.

(F) = Freshwater species.

(F?) = Possibly Freshwater species.

(U) = Unidentified.

TABLE 2. Weather Data for the South Coast of Ireland. (Courtesy of the Irish Meteorological Service).

Means of data from the stations at Rosslare (Co. Wexford) and Roches Point (Co. Cork).

1976	Mean Windspeed (knots)	Mean Daily Bright Sunshine (hrs)	Mean Daily Rainfall (mm)	Mean of Max-Min Temperature (°C)
July 18-24	9.5	2.0	Tr	14.6
July 25-31	8.6	5.4	Tr	15.0
August 1-7	6.9	2.0	Tr	15.4
Thirty Year Averages				
July	9.6	6.0	2.3	15.2
August	10.7	6.0	2.2	15.4

Tr = Trace.

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