

differences other than that represented by the Y antigen would be expected. It therefore seems unlikely, though of course not impossible, that immunization against Y antigen plays the part postulated for it by Renkonen *et al.*¹ in the antigenically complex situation of a human pregnancy in which the degree of immunization would presumably be weaker. In addition, studies on mice^{2,3} suggest that repeated pregnancies induce unresponsiveness to Y antigen, rather than even weak immunity.

The more detailed data published by Renkonen *et al.*¹⁰ do not convincingly support an immunological interpretation. For initiating and maintaining a state of immunity, boys born recently should prove more effective than those born longer ago. Yet it appears from their data that the earlier in the family boys are born, the greater is the depressing effect upon sex ratio. Where two boys are followed by two girls, for example, the ratio of boys to girls among fifth children is lower than when two girls are followed by two boys. This is the reverse of what an immunological hypothesis would lead one to predict.

ANNE McLAREN

Agricultural Research Council,
Unit of Animal Genetics,
Institute of Animal Genetics,
Edinburgh.

- ¹ Renkonen, K. O., Mäkelä, O., and Lehtovaara, R., *Nature*, **194**, 308 (1962).
² Mariani, T., Martinez, C., Smith, J. M., and Good, R. A., *Proc. Soc. Exp. Biol. Med.*, **101**, 596 (1959).
³ Billingham, R. E., and Silvers, W. K., *J. Immunol.*, **85**, 14 (1960).
⁴ Gorer, P. A., and O'Gorman, P., *Transpl. Bull.*, **3**, 142 (1956).
⁵ Snell, G. D., and Poucher, H., *Proc. Soc. Exp. Biol. Med.*, **54**, 261 (1943).
⁶ Snell, G. D., *Science*, **100**, 272 (1944).
⁷ Fekete, E., *Anat. Rec.*, **98**, 409 (1947).
⁸ Prehn, R. T., *J. Nat. Cancer Inst.*, **25**, 883 (1960).
⁹ Lengerová, A., and Vojtěšková, M., *Bol. biol. (Praha)*, **8**, 21 (1962).
¹⁰ Renkonen, K. O., Mäkelä, O., and Lehtovaara, R., *Ann. Med. exp. Biol. Fenn.*, **39**, 173 (1961).

Red Water and Mass-Mortality of Fish near Cape Town

RED water, caused primarily by a very high concentration of the dinoflagellate *Gonyaulax polygramma* Stein, associated with another dinoflagellate, *Prorocentrum micans* Ehrb., in smaller numbers, appeared in False Bay, near Cape Town, during March and the early part of April 1962. This bloom resulted in a mass-mortality of fish and marine invertebrates, when the dinoflagellates died in large numbers.

Red water is a common phenomenon around the coasts of South Africa and has been shown to be caused by a variety of different organisms, including dinoflagellates and ciliates. These different organisms appear to be the causes of several distinct phenomena, including mussel poisoning of man and mass mortalities of marine fauna. Sapeika¹ has shown that the pharmacological action of the toxin extracted from the local mussels is similar to that isolated from shell-fish in other parts of the world. Mass-mortalities of marine fauna are rare around the coasts of South Africa. Some early cases were reported by Gilchrist². Off the coast of South West Africa, however, complicated periodic mortalities occur as reviewed by Brongersma-Sanders³, and later studied by Copenhagen⁴. Mortalities farther north in Angola waters have been reviewed by Paredes⁵.

In the present case the mass-mortality of fish and invertebrates occurred in limited areas only when the red plankton died and decayed in large numbers.

The death of fish and invertebrates was apparently caused primarily by the depletion of oxygen in the water aggravated by the release of decay products. The living *Gonyaulax* up to the time they died do not appear to have produced any harmful effects on other fauna. Healthy patches of red water were found to be supersaturated with oxygen during the day.

Prof. N. Sapeika, of the Department of Pharmacology of the University of Cape Town, carried out toxicity tests on fish, limpets (*Patella longicosta*) and black mussels (*Mytilus perna*) we collected from the affected area. The mussels in particular would have become poisonous if there had been any toxic organisms present. However, an extract prepared from 12 black mussels by the Dack method produced no neurotoxic symptoms or death in six white mice injected with the material. Similar negative results were obtained by an independent medical specialist with other experiments.

The *Gonyaulax polygramma* population in this area showed considerable morphological variation as described by Taylor⁶. Observations on the non-thecate and cyst forms were similar to those of Sousa e Silva⁷ in cultures of *G. diacantha* (Meun.) Schiller. In *G. polygramma* it also appeared that multiplication occurred in the non-thecate stage. This species was found to be strongly luminescent. It is normally considered to be a warm-water species with a wide distribution in subtropical waters, and it only became abundant in the warm surface waters of False Bay. The organisms in this population were appreciably smaller than is characteristic for the species.

Gonyaulax polygramma was found in small numbers in the cold water south-west of Cape Town at the beginning of March. There was an influx of this cold, nutrient rich water into False Bay at this time associated with a period of south-east winds. In False Bay the surface-temperature rose, and the *Gonyaulax* multiplied rapidly in these favourable conditions. A period of two weeks of calms and northerly winds caused the plankton-rich water to accumulate and eventually to die and decay in certain limited areas where the concentration was greatest. The smell of decaying plankton and fish was noticeable in Cape Town 30 miles away. After a few days a change of wind direction dispersed the decaying plankton. Being largely a surface phenomenon wind was a primary factor in its distribution. A further period of calms resulted in a recurrence of the mass decay of plankton and another though smaller mortality of fish two weeks later. This case shows a remarkable similarity to mortalities due to *Gonyaulax polyedra* Stein on the coast of California and described by Kofoid⁸ and others. The only previous recorded case of a mortality due to *G. polygramma* was in Japan, where pearl-oyster beds were affected⁹.

JOHN R. GRINDLEY

South African Museum,
Cape Town.

F. J. R. TAYLOR

Department of Oceanography,
University of Cape Town.

- ¹ Sapeika, N., *Arch. Intern. Pharmacodyn.*, **93**, 135 (1953).
² Gilchrist, J. D. F., *Cape of Good Hope Mar. Biol. Rep.*, **2**, 8 (1914).
³ Brongersma-Sanders, M., *Verh. Akad. Wet. Amst.*, Sect. 2, **45** (4), 1 (1948).
⁴ Copenhagen, W. J., *S. Afr. Div. Fish. Invest. Rep.*, **14**, 1 (1953).
⁵ Paredes, J. F., *Notas Mimeo. centro. Biol. Piscul. (Lisboa)*, **26**, 1 (1962).
⁶ Taylor, F. J. R., *J. S. Afr. Bot.*, **28**, 237 (1962).
⁷ Sousa e Silva, E. de, *Bot. Mar.*, **3**, 75 (1962).
⁸ Kofoid, C. A., *Univ. Calif. Publ. Zool.*, **8**, 187 (1911).
⁹ Anon., *Nature*, **132**, 253 (1933).