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Observations on Some Massive Fish Kills in Lake Eyre

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Abstract

Large numbers of dead hairback herring *Nematalosa erebi* (Gunther) and hardyhead *Craterocephalus eyresii* (Steinachner) were found along the shores of Lake Eyre (Central Australia) in July 1975. The distribution and estimated abundance of dead fishes and the possible causes of the fish mortalities are discussed.

Lake Eyre consists of a large and relatively deep northern area (Lake Eyre North) connected by a narrow channel (Goyder Channel) to a smaller and shallower area (Lake Eyre South). In February 1974 Lake Eyre began filling with floodwaters, and fishes, from the northern rivers (Georgina, Diamantina and Warburton rivers and Cooper's Creek) and the salt crust on the bottom of the southern half of Lake Eyre North began to dissolve. By May, Lake Eyre reached a record height and Lake Eyre South was inundated for only the second time since European settlement (Dulhunty 1974, 1975).

On 15–16 July 1975 the author found large numbers of dead hairback herring *Nematalosa erebi* (Gunther) (family Clupeidae) and hardyhead *Craterocephalus eyresii* (Steindachner) (family Atherinidae) along the shores of both lakes during a chance visit to Lake Eyre. Four strand lines of fishes, each about 1 m wide (Fig. 1*a*) and about 25–30 m apart, were found on the north-eastern shore of Lake Eyre South but only three strand lines were observed in the south-eastern corner of Lake Eyre North (near Goyder Channel) and in the channel itself. The most recent fish kills (the lowest strand line in both lakes) appeared to be only about 2 weeks old whilst the oldest (the highest strand in Lake Eyre North) appeared to be at least several months old judging from the very dry and fragmented condition of the fishes. The residents of Muloorina homestead near Lake Eyre noted that dead fish first appeared along the shores at the beginning of 1975.

Many dead fishes of both species were found on shores facing all directions. This suggests that the strandings were the result of extensive fish kills and not just the result of wind transport of fishes from small or localized mortalities. In addition to the hairback herring and hardyhead, four specimens of golden perch *Plectoplites ambiguus* were found on a shore of Lake Eyre North near Goyder Channel. Another observation of interest was the incredibly large numbers of the chironomid *Tanytarsus barbitarsis* pupae and adults washed onto the shore of Lake Eyre South at about the same time as the last fish kill (Fig. 1*b*); live (adult) *T. barbitarsis* were so numerous in the late afternoon that the dense swarms restricted visibility and almost blacked out the horizon.

The very dry and decayed condition and the small size of the hairback herring in the highest stranding on Lake Eyre North (Fig. 2) suggest that this was the first kill to occur. The noticeably smaller size classes of hairback herring around Lake Eyre North (and Goyder Channel) (Fig. 2) suggest that the first kill in this lake occurred

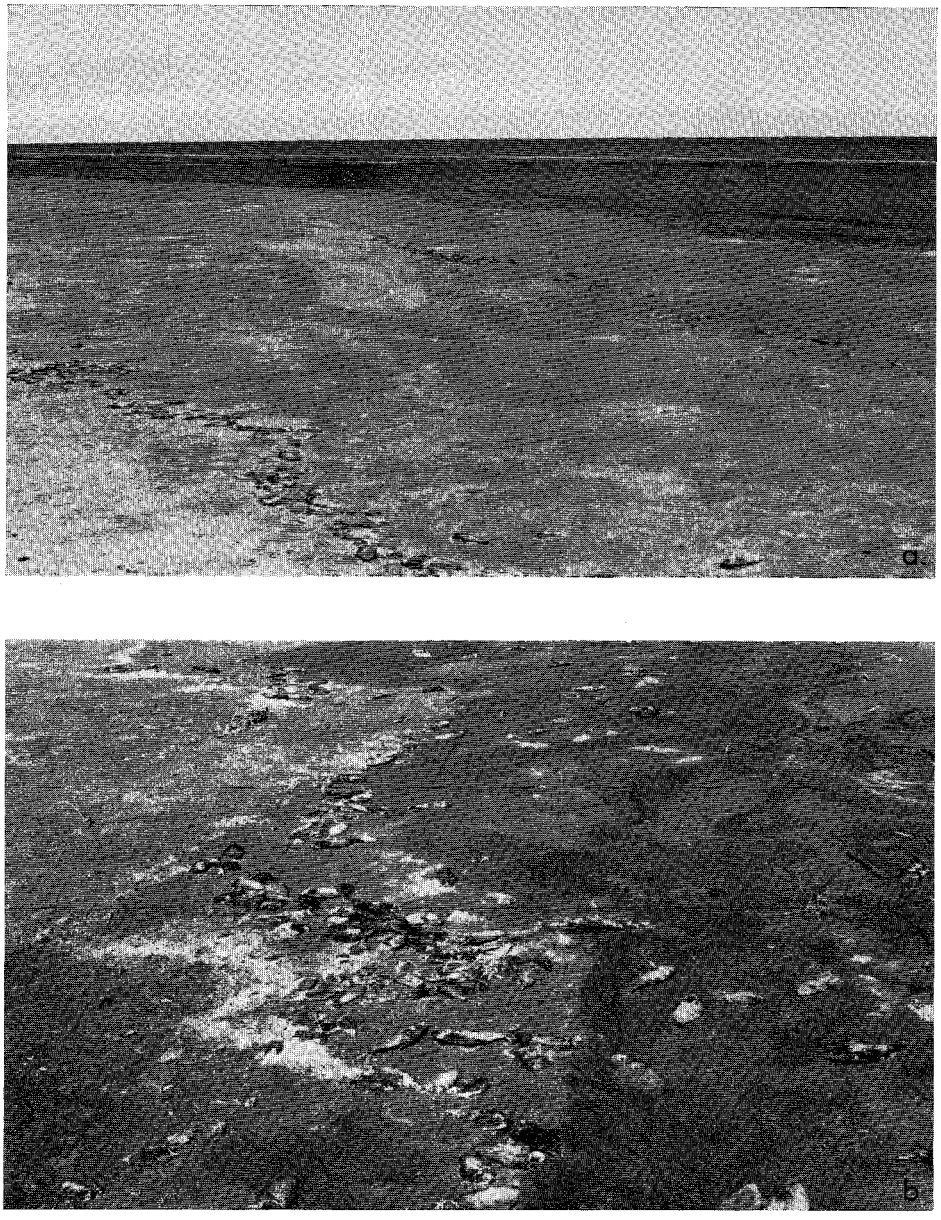

Fig. 1. (*a*) The shore along the north-eastern area of Lake Eyre South showing the three lowest strand lines of fishes. (*b*) The lowest strand line of Lake Eyre South showing the masses of chironomid *Tanytarsus barbitarsis* on the right-hand side of the photograph.

well before the first mortality in Lake Eyre South (assuming that the fish bred at approximately the same time in both lakes). The difference in the size of the fish in the first kill in the two lakes presumably reflects growth during the time period between the two fish kills; there is no reason to believe that the hairback herring in the two lakes had such a large difference in their growth rates. The progression in the modal length and in the largest size of hairback herring from the highest to the lowest strand line in Lake Eyre South presumably reflects the growth experienced in the time period between each fish kill. Fig. 2 also shows the size distribution of the hardyhead found along the north-eastern shore of Lake Eyre South (highest strand line).

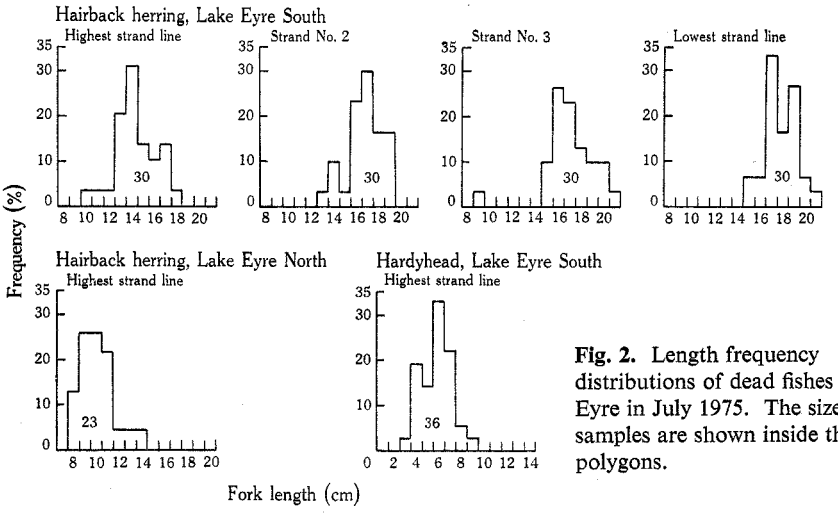

Fig. 2. Length frequency distributions of dead fishes in Lake Eyre in July 1975. The sizes of the samples are shown inside the polygons.

The highest strand line in all areas visited contained large numbers of hairback herring and hardyhead whereas the other strands had very few hardyhead. Several hundred fish of both species were generally found per metre of shoreline along Lake Eyre South. The highest density of hardyhead observed along this lake was approximately 720 fish per metre of shoreline (almost all in the highest strand) whereas the highest density of hairback herring was about 320 fish per metre and the fish were generally found in almost equal densities in all strand lines.

Dr J. A. Dulhunty visited many areas of Lake Eyre between August and October 1975 and found large numbers of hairback herring and hardyhead in all localities. From his observations and mine I have concluded that 150 is a reasonable estimate of the average number of fish of both species found per metre of shoreline. As approximately 1330 km of shore (including part of Frome Creek) were littered with fish the total number of dead fish was estimated to be about 20 million of each species.

The fish production of Lake Eyre, as demonstrated by the number and size of dead fish around its shores, is remarkable. The dead hairback herring had an average live weight of about 100 g, therefore the total hairback herring kill amounted to approximately 2 million kg whilst the total hardyhead kill was about 0·08 million kg (average weight about 4 g per fish). The total production of fish in Lake Eyre in 1975 was obviously greater because there were still fish alive in December 1975 (J. Glover, personal communication). Furthermore, large quantities of fish would have been

consumed by the thousands of fish-eating birds (pelicans *Pelecanus conspicillatus*, black cormorants *Phalacrocorax carbo*, and whiskered terns *Chlidonias hybrida*) observed at Lake Eyre in July 1975. Brown and Urban (1969) calculated that an adult pelican *Pelecanus onocrotalus roseus* consumes about 1 kg of fish per day. At this rate the estimated 500 pelicans observed in July may have consumed 0·18 million kg of fish from Lake Eyre in 1975.

The stomachs of four fresh hairback herring were examined and found to contain chironomid larvae *Tanytarsus barbitarsis* and an ostracod (crustacean) *Diacypris* sp. The diet of the hardyhead was not examined.

The cause(s) of the fish kills was not apparent in July 1975 and still remains unclear. The water in both lakes appeared satisfactory for aquatic life but could not be analysed *in situ*. A sample of about 2 litres of surface water from the southern end of Lake Eyre North was taken to Sydney and analysed by my colleague E. A. Scribner. His results are shown in the Appendix. The relatively high chlorophyll count (see Appendix) was probably the result of continuing photosynthesis in the bottle (which, regrettably, was not blackened).

The high salinity of Lake Eyre would seem to be a likely cause of the fish mortalities. The *surface* salinity at the southern end of Lake Eyre North was approximately 39‰ in July 1975 when many fish of both species were still alive in the lake. J. Glover (personal communication) found freshly dead hairback herring and hardyhead in Lake Eyre North in December 1975 when surface salinity was measured at approximately 80‰. Many individuals of both species can apparently tolerate rather high salinities. However, Lake Eyre North has had a layer of water, about 1 m deep, along the bottom with salinity ranging from about 50 to more than 300‰ since July 1974 (J. A. Dulhunty, personal communication). Such highly saline waters would probably prove lethal to most fishes. The fish kills, in Lake Eyre North in particular, may therefore have been a result of high salinities produced by the mixing of bottom and surface water by wind-induced seiches such as those reported for Lake Eyre by Bonython and Mason (1953).

Low water temperature or a rapid drop in temperature are also likely causes of the fish mortalities, particularly for the hairback herring and especially those in the (shallow) Lake Eyre South. Lake (1971) noted that large numbers of *Fluvialosa richardsoni* (= *Nematalosa erebi*) may die as a result of low temperature or a fall in water temperature. Furthermore, New South Wales State Fisheries has had many reports from inland Fisheries Inspectors endorsing Lake's explanation of the mass mortalities of *F. richardsoni*.

An algal bloom may have indirectly produced a fish kill by reducing the oxygen content of the water; J. A. Dulhunty (personal communication) frequently encountered algal blooms during his visits to Lake Eyre between 1972 and 1975. Coe (1966) suggested that the deoxygenation of water following an algal flush (bloom) was the most likely cause of a mass mortality of the fish *Tilapia grahami* in Lake Magadi in Kenya in 1960. Brown and Urban (1969) suggested that a kill of *T. grahami* in Lake Natron, Ethiopia, in 1962 was probably due to anoxia or gill clogging by an algal bloom.

There is no evidence suggesting that diseases or parasites were a cause of the fish mortalities. All of the dozen or so freshly dead hairback herring and hardyhead examined showed no macroscopic parasites or external damage. The hairback herring

were dissected and were found to be in good physical condition and to have large fat deposits in their abdominal cavities.

The aquatic fauna of Lake Eyre is poorly known. Bayly (1976) has contributed to our knowledge of the plankton of Lake Eyre; hopefully more biologists will have the opportunity for field study on Lake Eyre before it dries up again.

Acknowledgments

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Appendix

Analyses of a surface water sample taken from the southern end of Lake Eyre North on 16 July 1975 are shown below. The analyses were conducted by E. A. Scribner, New South Wales State Fisheries, Water Quality and Primary Production Laboratory.

Physical measurements	Specific gravity	1·026
	Conductance	57 500 μS at 25°C
	pH	7·2
Minerals	Total alkalinity	78
	Total hardness	1960 } mg/l as $CaCO_3$
	Calcium hardness	890
	Chloride	23 000 mg/l
	Chlorinity	22·4‰
	Anions of strong acids	675 m-equiv/l
Nutrients[A]	Oxidized nitrogen	34 μg N/l
	Nitrite	2 μg N/l
	Reactive phosphorus	3 μg P/l
	Total soluble phosphorus	35 μg P/l
	Reactive silica	20 μg-atom Si/l
	Chlorophyll *a*	44·5 μg/l
	Phaeophytins	6·9 μg/l

[A] These data must be treated with caution because the water was held in an undarkened bottle for 1 week prior to analysis.

Appendix (*continued*)

		Concentration (m-equiv/l)	(mg/l)	Percentage equivalent
Cations	Sodium	637	14 650	47
	Magnesium	21	260	2
	Calcium	18	356	1
Anions	Chloride	649	23 000	48
	Sulphate	26	1 260	2
	Bicarbonate	1·6	95	0

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