

COMMENT

Lipid nutrition and fish recruitment

M. V. Bell*, J. R. Sargent

NERC Unit of Aquatic Biochemistry, Department of Biological and
Molecular Sciences, University of Stirling, Stirling FK9 4LA,
Scotland, United Kingdom

*E-mail: mvb1@stirling.ac.uk

*Browman HI (1995) Commentaries on current research trends
in recruitment studies. Mar Ecol Prog Ser 128:305–310*

We followed the above commentary with great interest. We believe that the importance of larval nutrition, and especially lipid nutrition, has been overlooked in the debate on fish recruitment.

Vertebrate neural tissue, particularly photoreceptor cells, contains a large proportion of its fatty acids as docosahexaenoic acid (22:6n–3), largely as di22:6n–3 molecular species of phospholipids in the outer segment membranes of rod cells (Fliesler & Anderson 1983, Louie et al. 1988). These unique lipids are essential for the function of rhodopsin in the first stage of the visual process (Brown 1994); no other fatty acid can substitute functionally for 22:6n–3 in this system. Many marine fish cannot synthesise 22:6n–3 from shorter chain precursors and are therefore totally dependent on the diet for this fatty acid (Sargent et al. 1989). Most larval fish have a cone-only retina at hatching, rod cells appearing from metamorphosis onwards (Blaxter & Jones 1967, Powers & Raymond 1990). There is therefore a very large demand for 22:6n–3 in early larval development which must be met from the diet. We have recently shown that a dietary deficiency of 22:6n–3 during early (rod) development in juvenile herring results in a very low amount of di22:6n–3 phospholipid in the retina and an inability to feed at low light intensities when rod vision is required (Bell et al. 1995). The work of Blaxter and Batty on herring vision has shown that predator evasion behaviour also evolves at the time that rod cells first appear in the photoreceptor population (Batty 1989). Thus a deficiency of 22:6n–3 in early development will lead to an inability to feed (i.e. starvation) and increased predation.

There is a large literature detailing the fatty acid composition of many species of marine algae. Briefly, diatoms are dominated by C16 polyunsaturated fatty acid (PUFA) and eicosapentaenoic acid (20:5n–3) while flagellated algae such as prymnesiophytes and

dinoflagellates contain large amounts of 22:6n–3 and C18 PUFA but little 20:5n–3 or C16 PUFA (Sargent et al. 1987). The survival of first-feeding fish larvae is therefore dependent not merely on the availability of 'phytoplanktonic food' but also on the availability of a specific nutrient present in a specific class of phytoplankton, transmitted directly or via zooplankton to fish. Zooplankton fatty acids are rapidly and directly influenced by the phytoplankton (Fraser et al. 1989, Graeve et al. 1994). The timing of diatom and flagellate blooms in relation to larval emergence therefore becomes all-important for maximal growth and survival of fish larvae, stemming from their performance in catching prey and their performance in avoiding predators. The species composition of phytoplankton blooms is highly variable spatially and temporally (Kattner et al. 1983) but it is unclear whether it is possible for phytoplankton deficient in 22:6n–3 to dominate blooms at critical times in early fish larval development. We believe nutritional considerations such as these could be crucial for the growth, behaviour and ultimate survival of fish larvae, and thus recruitment to adult stocks.

LITERATURE CITED

- Batty RS (1989) Escape response of herring larvae to visual stimuli. *J Mar Biol Ass UK* 69:647–654
- Bell MV, Batty RS, Dick JR, Fretwell K, Navarro JC, Sargent JR (1995) Dietary deficiency of docosahexaenoic acid impairs vision at low light intensities in juvenile herring (*Clupea harengus* L.). *Lipids* 30:443–449
- Blaxter JHS, Jones MF (1976) The development of the retina and retinomotor responses in the herring. *J Mar Biol Ass UK* 47:677–697
- Browman HI (1995) Commentaries on current research trends in recruitment studies. *Mar Ecol Prog Ser* 128:305–310
- Brown MF (1994) Modulation of rhodopsin function by properties of the membrane bilayer. *Chem Phys Lipids* 73: 159–180
- Fliesler SJ, Anderson RE (1983) Chemistry and metabolism of lipids in the vertebrate retina. *Prog Lipid Res* 22:79–131
- Fraser AJ, Sargent JR, Gamble JC, Seaton DD (1989) Formation and transfer of fatty acids in an enclosed marine food chain comprising phytoplankton, zooplankton and herring (*Clupea harengus* L.) larvae. *Mar Chem* 27:1–18
- Graeve M, Kattner G, Hagen W (1994) Diet-induced changes in the fatty acid composition of Arctic herbivorous copepods: experimental evidence of trophic markers. *J Exp Mar Biol Ecol* 182:97–110
- Kattner G, Gercken G, Eberlin K (1983) Development of lipids during a spring plankton bloom in the northern North Sea. *Mar Chem* 14:149–162

- Louie K, Wiegand RD, Anderson RE (1988) Docosahexaenoate-containing molecular species of glycerophospholipids from frog retinal rod outer segments show different rates of biosynthesis and turnover. *Biochemistry* 27:9014–9020
- Powers MK, Raymond PA (1990) Development of the visual system. In: Douglas RH, Djamboz MBA (eds) *The visual system of fish*. Chapman & Hall, London, p 419–442
- Sargent JR, Parkes RJ, Mueller-Harvey I, Henderson RJ (1987) Lipid biomarkers in marine ecology. In: Sleigh MA (ed) *Microbes in the sea*. Ellis Horwood Ltd, Chichester, p 119–138
- Sargent JR, Henderson RJ, Tocher DR (1989) The lipids. In: Halver JE (ed) *Fish nutrition*, 2nd edn. Academic Press, San Diego, p 152–218