ground coloration or brightness may permit an evaluation of some sensory capacities of lower "social" organisms, independent of the controversy associated with learning in lower organisms.

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[1] Pearl, R., *Quart. J. Microsc. Sci.*, **46**, 509 (1903). Walter, H. E., *J. Exp. Zool.*, **5**, 35 (1907). Allee, W. C., *Animal Aggregations* (University of Chicago Press, 1931).
[2] Reyniersе, J. H., *Animal Behav.*, **14**, 246 (1966); **15**, 270 (1967).
[3] Reyniersе, J. H., and Ellis, R. R., *Nature*, **214**, 895 (1967).
[4] Fraenkel, G. S., and Gunn, D. L., *The Orientation of Animals* (Dover Publications, 1961).
[5] Siegel, S., *Nonparametric Statistics for the Behavioral Sciences* (McGraw-Hill, 1956).
[6] Tinbergen, N., *Social Behaviour in Animals* (Methuen, 1953).
[7] von Frisch, K., *The Dance Language and Orientation of Bees* (Harvard University Press, 1967). Lindauer, M., *Communication Among Social Bees* (Atheneum, 1967).
[8] Jacobson, A. L., *Psychol. Bull.*, **60**, 74 (1963). Best, J. B., in *Learning and Associated Phenomena in Invertebrates* (edit. by Thorpe, W. H., and Davenport, D.) (Baillière, Tindall and Cassell, 1964).
[9] Jensen, D. D., in *Learning and Associated Phenomena in Invertebrates* (edit. by Thorpe, W. H., and Davenport, D.) (Baillière, Tindall and Cassell, 1964).

Isolated Population of *Elminius modestus* (Crustacea: Cirripedia) in Northumberland

THE immigrant barnacle *Elminius modestus*, spreading from the Channel, has been known for several years in the North Sea, being reported from the Thames before 1948 (refs. 1 and 2), from the Humber in 1951 (ref. 2) and from near the Tees in 1958 (ref. 3). There its northwards progress along the east coast was arrested; however, a separate settlement, doubtless introduced by shipboard agency, flourishes in the Forth[4], extending as far south as Dunbar. The intervening coast has remained uncolonized until recently, despite a considerable seaborne traffic between the Thames and the principal rivers of Northumberland and Durham. Apart from those found on ships' bottoms, a specimen settled on a mussel in the River Blyth in 1950 and two specimens settled on a mussel in the River Tyne in 1961 constitute the only records from these counties until this year.

Now a colony has been found in a very restricted locality at Newton-by-Sea (lat. 55° 31′ N) in north Northumberland. It was first observed in April of this year at the root of the Emblestone rocks, the colony occupying an area 200 × 150 m at mid-tide level. Here it constitutes about 20 per cent of the barnacle population. *Elminius* is absent from adjoining stretches of rocky coast. Prompted by the Newton discovery search was made at a dozen places between West Hartlepool and Eyemouth in Scotland. Only at West Hartlepool and Seaham, both close to the Tees, were a very few specimens found.

The date of the Newton Bay settlement is unknown, but the area is visited annually by a class of university students and teachers, some of whom are familiar with the species from elsewhere, and it has not previously been collected at Newton. The origin of the colony is also in doubt. No ships other than local fishing cobles call here and the larvae must have been carried by currents from the Forth, 46 sea miles distant, or from the Tees, 55 miles distant. The predominantly southerly set makes the Forth the more likely source.

It is remarkable that *Elminius* is not found at intermediate places. Yet Newton Bay is also noteworthy for a number of sand-dwellers absent or not commonly found on other Northumbrian beaches, *Echinocardium*, *Cochlodesma*, *Ensis*, *Lanice* and *Venus* being examples. It is an exceptionally sheltered region, yet not estuarine, and may represent the sole Northumbrian locality favourable for a barnacle living at the extreme limit of its range. The arrival of *Elminius* adds one more peculiar species to the unique fauna of this bay.

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[1] Knight-Jones, E. W., *Nature*, **161**, 201 (1948).
[2] Crisp, D. J., *J. Mar. Biol. Assoc. UK*, **37**, 483 (1958).
[3] Crisp, D. J., *Nature*, **188**, 681 (1960).
[4] Jones, D. H., *Nature*, **190**, 103 (1961).

Seawater as a Source of Plant Nutrients

THE use of seawater as a practical growth culture medium and a source of essential nutrients for algae and other plants has been studied. The results obtained, using the green alga *Chlorella pyrenoidosa*, show that seawater provides a wealth of nutrients and is a cheap nutrient concentrate which when diluted and properly supplemented can support optimum plant growth.

The mineral requirements for autotrophic growth of *Chlorella* have been determined[1,2]. The chemical composition of seawater is also known[3]; it has an abundance of mineral nutrients and is deficient only in nitrate, phosphate and perhaps available iron and some trace elements such as manganese and molybdenum.

Knowing the mineral requirements for the autotrophic growth of *C. pyrenoidosa* and the composition of seawater, it can be shown that seawater, when diluted twenty-five-fold with fresh water, still contains adequate amounts of magnesium, sulphur and potassium to support photosynthesis and growth of *Chlorella* (Table 1). Nitrate, phosphate, iron, manganese and molybdenum need to be added to the diluted seawater.

Table 1. THE ELEMENTAL COMPOSITION OF SEAWATER AND INFORMATION ON CRITICAL AND MINIMUM CONCENTRATION REQUIREMENTS FOR ALGAL GROWTH

Element	Concentration (mg/l.)	Critical concentration* (mg/l.)	Fold dilution† of seawater	Minimum concentration‡ (mg/l.)	Fold dilution§ of seawater
Sodium	11,100	1		0·01¶	
Magnesium	1,330	46	29	0·046	29,000
Calcium	420	(0·3)‖	1,400		
Potassium	390	17	23	0·17	2,300
Chlorine	19,800				
Sulphur	920	6	153	0·06	15,300
Bromine	66				
Boron	5	(0·1)‖	50		
Phosphorus	0·08	6			
Iron	0·001 to 0·06	1		0·01	
Zinc		0·05		0·00005	
Manganese	0·001 to 0·01	0·005		0·00005	
Molybdenum		(0·01)‖			

Calculated values are given for the number of times seawater can be diluted to reach the critical concentration and the minimum concentration for each element.

* Required for *C. pyrenoidosa* except sodium is that required by *Nostoc muscorum* and other blue-green algae. Critical concentration is the lowest concentration which still produces optimum or maximum growth.

† Which will lower the concentration of the respective element in seawater to the critical concentration.

‡ Required for *C. pyrenoidosa*. Minimum concentration is the concentration below which there is no growth.

§ Which will lower the concentration of the respective element in seawater to the minimum concentration.

‖ Required by *N. muscorum* for nitrogen fixation. Calcium and molybdenum are required for other functions at concentrations 1,000-fold less.

¶ Required by *N. muscorum*.