get and non-target nuclei. Reports on this point are conflicting, both tissue specificity (Higgins *et al.*, *J. biol. Chem.*, **248**, 5873; 1973) and lack of specificity (Chamness, *op. cit.*) have been reported.

Perhaps the situation will only be finally resolved when purified receptor is available and it is possible to clone the DNA fragments containing the controlled gene and its operator region and so study receptor binding *in vitro*. Two systems are presently being explored in this manner, the control of ovalbumin synthesis in the oviduct (Woo *et al.*, *J. biol. Chem.*, **251**, 3868; 1976) and the glucocorticoid regulation of mouse mammary tumour virus (see *News and Views*, **259**, 193; 1976). □

Fish schooling

from John Krebs

Two recent papers have shed interesting new light on fish schools. Many species of fish swim in polarised and coordinated groups containing anything from half a dozen to many thousands of individuals, according to the species. Pitcher *et al.* (*Science*, **194**, 963; 1976) have investigated the sensory mechanisms involved in schooling, and Breder (*Fish Bull.*, **74**, 471; 1976) has suggested a new functional explanation for the schooling habit.

In the past, several workers have emphasised the importance of vision in schooling: schools of various species tend to break up at low light intensities. Pitcher *et al.* studied the schooling abilities of Saithe (*Pollachius virens*) fitted with black plastic eye-cups. These temporarily blind fish could be scooped out of the water showing no attempt to avoid the net, but could still join and maintain their position in a fish school swimming around a large circular tank. The blind fish showed some small differences in behaviour: they moved from side to side within the school more than their companions, but in the Saithe at least, vision is clearly not necessary for schooling. Pitcher *et al.* go on to show that if the lateral line system of pressure detectors is cut, the blind fish no longer school, which seems to show that the blind Saithe use water movements created by their companions in order to stay in position in the school.

The adaptive significance of schooling is also much debated and several hypotheses (not mutually exclusive) have emerged. One is that schools are an anti-predator adaptation, the idea being that the individuals in a school "seek cover" from potential attackers by hiding behind a fellow schooler

(Hamilton, *J. theor. Biol.*, **31**, 295; 1971). This might be called the "after you" principle. Experiments have shown that predators also tend to be confused when faced with a milling school of prey, so that attack success goes down (Neill and Cullen, *J. Zool. Lond.*, **172**, 549; 1974). Another possible benefit of being in a school is that each individual is able to parasitise (by copying) the success of its companions in finding good feeding places: an effect well known to fishermen and blackberry pickers. A less well-documented possibility is that there may be a hydrodynamic, energy saving, advantage of schools. As a result of its swimming movements, each fish produces a series of vortices in the water to either side of its body, and if a following fish swims in exactly the right spot, it could in theory get a forward boost from the vortex, allowing it to free wheel and save energy (Weihs, *Nature*, **241**, 290; 1973). Only the hapless individuals at the front gain nothing, but fish are known to jostle for positions at the back and centre of a school, and this hydrodynamic theory may explain why. Breder also suggests a hydrodynamic advantage which would benefit all but the front swimmers. He notes that the mucus produced by the bodies of fish has an important effect in reducing frictional drag. In some species even a 5% solution of mucus can reduce drag by up to 60%. Breder's idea is that fish in a school (except for the front swimmer) benefit not only from their own mucus, but from the slime washing off the bodies in front of them. He suggests that schooling may have originated simply as a consequence of fish finding it energetically easier to swim along behind someone else.

Breder's suggestion is an addition rather than an alternative to the anti-predator and feeding advantages of schooling. In fact, to explain the differences between species of fish in their tendency to form schools, one will have to look for ecological factors such as the risk of predator attacks, since the hydrodynamic advantage probably would apply roughly equally to all fish. □

Troubled waters

from Peter D. Moore

THE art of compromise may not be dead, but it is certainly not thriving, judging by the views put forward at a conference (Recreation and Conservation in Water Areas) held by the Royal Society of Arts in London on November 22. The meeting succeeded in demonstrating that there is little common ground, or water, between the

two interests. Such a state of affairs is predictable, for bird watchers and their ilk have never been noted for their affection towards water-skiers and power-boat drivers, but what does seem remarkable is the total lack of understanding which each group of water-users has of the others interests and requirements. The problem is a very real one for the regional Water Authorities, which were set up under the 1973 Water Act. This same Act makes these Authorities responsible for making their waters and associated lands available for public recreation (Section 20) and also places statutory obligation upon them to grant public access and to have regard to conservation interests (Section 22). Whether they like it or not, the Water Authorities must try to satisfy all demands.

B. Hackett (University of Newcastle-upon-Tyne) represented the landscape designer's point of view and evidently found considerable aesthetic appeal in the geometrical, concrete-edged lake within a built landscape setting. Many may share his view, but he cannot expect enthusiasm from the angler or the wildlife conservationist; neither can he expect these groups to be responsive to his 'semi-natural' compromise, which is a body of water surrounded by carefully selected shrubs and neatly planted flower beds. For the planner, I suppose, nature can only be attractive when planned.

Then there is the true recreationist. Does N. R. Collins (Sports Council) really believe that the disturbance created by water skiers reoxygenates water, or was that a joke? Even if it were demonstrably true I cannot imagine the three million odd British anglers being very impressed. There is no chance of compromise here.

C. Newbold (Nature Conservancy Council) presented a distinctly unpromising statement of the conservationist's position. Quoting the work of Hume (*Br. Birds*, **69**, 178; 1976) he explained that a power boat puts diving ducks (the goldeneye for example) to flight at a range of 500–700 m, sailing boats do so at 350–400 m and people on the bank at 100–200 m. He rather assumed that the latter would be anglers, but they could equally well be bird watchers themselves. The figures do, however, serve to highlight the conflict of interests between bird watchers and just about all other water users. The vociferous and adverse audience reaction to Newbold's suggestion that the construction of a restaurant on the shores of the Loch Insh Nature Reserve was a retrograde step in terms of amenity, ably demonstrates that 'amenity' can mean different things to different people.

Wildfowling has had much experience in respecting the needs of others