EEL MIGRATION

IT seems probable that many of the difficulties that have undermined Dr. Tucker's belief[1] in the ability of European eels to return to the Sargasso Sea would have disappeared if he had compared the European eel with the Atlantic salmon, the return of which to spawn after a migration of comparable difficulty is more readily demonstrable.

Salmon, both Atlantic and Pacific, migrate to feed in the sea: here they may stay for one and a half to four or more years. This active feeding period is followed by a spawning migration during most of which the animal does not feed. Fasting begins as the salmon nears fresh-water; the subsequent migrations upstream, often carried out under difficult physical conditions, are very fatiguing and call for a considerable expenditure of energy. Yet, after a migratory fast lasting up to a year, millions of salmon survive to partake in most energetic spawning activities. In fact, about 5 per cent return to spawn again, and a small proportion may spawn three times.

Eels spend most of their lives feeding in fresh-water. This feeding period of from six to twenty-five years duration is as clearly preliminary to spawning migration as are the years spent by the salmon in the sea. I do not agree with Dr. Tucker that European silver eels are starving and debilitated: the many thousands that I have handled have been vigorous, extremely energetic and in good condition. It is of interest that eel-dealers store living eels for long periods, yet these eels are in the end still fat enough to be sold as highly nutritious food.

On their 3,500-mile spawning journey, eels have to contend only with slow-moving ocean currents, not to be compared with the fast-flowing streams encountered by salmon. If eels travel at a modest 40 miles a day, the journey need take only thirteen weeks—not a long fast compared with that of many salmon.

Dr. Tucker claims that American eels, because of their larger size and apparently juvenile sex condition, are better suited than European eels for their spawning migration. But size is not a criterion of condition; salmon, ranging from 3½ lb. to more than 60 lb., complete their spawning migration successfully; many reach the rivers of Britain in an advanced stage of sexual maturity, fast, and survive to spawn. Recent examinations of the state of the gonads in large samples of eels have convinced me that the European silver eel is not "already well advanced towards being a reproductive oceanic fish". The gonads of silver eels are not in an advanced stage of development. Many silver eels migrate when their gonads are scarcely more advanced than those of yellow eels. In fact, the gonads of the silver eels are in about the same developmental stage as those of female salmon smolts and unspawned male smolts.

One of the most strongly emphasized points in Dr. Tucker's argument is that European silver eels are rarely caught at sea. But neither apparently are American eels. Nor is it surprising that eels at sea are elusive. They do not feed and so cannot be caught on long-lines, nor are they likely to stay captive in any normal deep-sea trawl. It is no cause for astonishment that eels are not caught in the Straits of Gibraltar, for no commercial fishing gear in use there can be expected to catch eels. Salmon are rarely caught off shore, and salmon should be much more catchable, for they feed in the sea, they stay there much longer and they are not so shaped as to make escape from nets easy. Yet countless millions reach their spawning grounds yearly, though the number caught in the open sea is very small.

Finally, Dr. Tucker's hypothesis requires that a large proportion of the American eel population is 'lost' yearly as a reproductive potential, since American eels which spawn in the wrong place produce progeny which become European eels and never succeed in spawning. If this were a true account, there would be intense selection in favour of eels which found the 'right' spawning ground. It would be very surprising if natural selection on this large scale had failed to eliminate the European eel in a few generations.

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[1] Tucker, D. W., *Nature*, **183**, 495 (1959).

I MUST emphasize at the outset that Dr. Jones's communication, even if it were acceptable in its entirety, contains nothing relevant to the fundamental problem of eel navigation and nothing which has any bearing upon my hypothesis that the two Atlantic *Anguilla* phenotypes may be environmentally differentiated and distributed without genetic intervention. For the rest, the difficulties which led to a heavily documented paper[1] are not likely to be dispelled by criticism which ignores not only literature already cited, some of it on two occasions[1,2], but also that relevant to its own substantiation. Moreover, a recent independent review[3] has made such a comparison as Dr. Jones demands, and without detriment to the new theory of eel migration.

Both the salmon and the eel undergo migrations which raise problems of navigation, physical effort, condition and osmo-regulation. Thereafter the comparison breaks down to such an extent that knowledge of one casts little light on the ways of the other. The eel is catadromous; the salmon anadromous. The first migration of the eel is as a larva passively transported in the surface layers; its second as a starving adult travelling in the deeper layers and probably by a different return route. Both of the migrations of the salmon are accomplished as an adult fish, travelling in substantially the same water-masses along the same routes and actively feeding until the final return to fresh-water. Eels are in peak condition shortly before the commencement of their final journey; salmon shortly before the end of it.

The European eel is, in Dr. Jones's view, an ocean traveller, accomplishing a long journey of at least 3,500 miles for the south-west European stocks and at most 5,000–6,000 miles for the White and Black Sea stocks. The longest recorded journey for an Atlantic salmon is 1,730 miles in 328 days[4]; characteristically, its migrations are much shorter—a few hundred miles along the coast or to and from feeding-grounds off the shelf—and fairly easily explained by internal changes in the osmo-regulatory mechanism