

on 'clean' glasses. Whisky and wine glasses were found to be less contaminated. Beer and overflow beer were also examined with results which were not entirely satisfactory. Undiluted overspill beer languishing in its tray until it can be dealt with may contain washings off the bar tenders' fingers and will not improve any fresh beer with which it is eventually mixed. Coliforms were isolated from six samples of overflow beer in numbers up to 100/ml. *Staph. aureus* was isolated from two samples and *Strep. viridans* from four. Non-haemolytic streptococci were found in three samples. There is, however, no evidence in the literature that anyone ever contracted infectious disease by drinking beer out of glass or pewter in a public house.

There was far too little hot water available in public houses and when available the temperature of use was too low. Though glass-washing machines with hot and cold jets are very good when economically suitable, it is felt that a foolproof method such as the regular dispensing of a quaternary ammonium germicide into the washing water with, when there is room, a second rinsing sink properly maintained, furnishes a generally suitable and easily worked way of securing a clean glass. In all methods sensible application is essential. The survey showed that in the houses visited sanitary arrangements for the public, especially for females, could be much improved.

As in the investigation of restaurant kitchens, the survey resulted in improvements being carried out in some houses.

#### REFERENCE

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### **The effect of spoilage and handling on the bacterial flora of fish**

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For a number of years, investigations have been proceeding at the Torry Research Station, Aberdeen, on the bacterial flora of newly caught fish and the effect thereon of spoilage in ice and of handling on board ship or on shore. However, it is only within the past 5-6 years that anything like the necessary resources and techniques have been available to tackle these problems adequately. As a result, we now have for the first time a fairly comprehensive picture of the flora of four species of newly caught fish (haddock, cod, lemon sole and skate) from the North Sea, and we have also begun to accumulate data on the effects of spoilage and handling.

The flesh of newly caught fish is sterile, but bacteria are always present on the skin and gills, and in enormous numbers in the gut of 'feedy' fish. The loads on the skin and gills generally vary between 100 and 1 million/sq. cm of skin or per g of gill

tissue and up to 10 million/g of faeces. In general trawled fish have heavier loads than lined fish, but the counts on both these groups may vary with season.

Qualitatively the flora consists mainly of *Pseudomonas* and *Achromobacter* spp., the former accounting for about 50% of the total flora, the latter for 40%. The remainder is made up of species of *Flavobacterium* (5%), *Corynebacterium* (2%), *Micrococcus* (2%) and miscellaneous groups. Despite repeated attempts, no enterobacteria have been found, although they are said to occur in newly caught fish from polluted waters. This general picture of the flora holds good for all the four species of North Sea fish so far examined. It appears also to hold good for herring caught in Shetland waters and off the Norwegian coast, and for cod caught off Norway and Bear Island. It differs, however, markedly from results obtained in Canada (for cod) and in Australia (for several species of fish), but these differences are probably due to environmental conditions—in Australia for instance the sea-water temperatures are much higher than in the North Sea—and possibly also to species differences.

In normal practice, after the fish are caught, they are gutted, washed in sea-water and stowed below in the hold in crushed fresh-water ice. As might be expected, all these treatments affect the flora, both qualitatively and quantitatively. Thus washing after gutting may reduce the skin load by 80–90%, but icing may increase it again up to or even beyond that originally present on the newly caught ungutted, unwashed fish. This is because ice on board ship seems to acquire quickly a large number of bacteria, usually of species similar to those on fish.

The fish may remain only a few days in the ship's hold before reaching port, as with inshore or near-water vessels. On the other hand, the bulk of the fish landed in this country comes from the distant waters, where the last caught fish are usually 5 days in ice before landing and the first caught ones anything from 12 to 18 days. During the period of stowage on board, the flora, as would be expected, changes both qualitatively and quantitatively. By about the 3rd–4th day in ice, the lag phase of growth is passed and by the 10th–12th day, the end of the logarithmic phase, counts in the region of 10–1000 million are reached.

Qualitatively several interesting facts have recently been observed at Torrey. As spoilage proceeds, the proportion of pseudomonads steadily increases until by about the 10th–12th day they constitute 90% of the flora, the *Achromobacter* spp. now forming only about 5%. At about the 12th day the *Flavobacterium* spp. show a transient increase with a corresponding decline in the *Pseudomonas* spp. It is of interest to note that at this point (12th day), there are significant changes in both the chemical and organoleptic aspects of spoilage. However, the *Pseudomonas* group again increase after this point until after 21 days they once more constitute about 90% of the total viable population. The remainder consists of *Achromobacter* (5%) and *Flavobacterium* spp. (2%). This general picture has been obtained in six separate experiments at different times of the year with cod; but though it probably shows what normally happens during spoilage of this species, it is not necessarily true for others.

As the fish are handled, particularly on shore, this general picture of the flora

can be altered. This is well illustrated by some intensive work recently completed on the filleting process at commercial premises. With newly caught fish, the counts on fillets generally range between 10,000 and 100,000/sq. cm of skin or flesh surface; with staler fish the counts are generally higher, especially on the skin. Qualitatively the flora shows some interesting alterations, terrestrial forms now being encountered to a considerable degree. Thus, in both skinned and unskinned fillets made from fish less than 1 day from catching, the flora consists of species of *Pseudomonas* (46%), *Achromobacter* (24%), *Corynebacterium* (20%) and the remainder of *Micrococcus* and *Flavobacterium*. At some premises cocci have been encountered in greater numbers, and the flora may well vary markedly from fish house to fish house.

Some work has also been done recently by one of us (D.L.G.) on the incidence of coliforms, shigellas and salmonellas and coagulase-positive staphylococci, on fish from the point of catching until filleting has been completed. Several such surveys have now been done over the past year with the same results. Shigellas and salmonellas have never once been encountered. True faecal coli have been encountered only at the filleting stage, on filleting benches and on the fillets themselves, but the numbers have been very low. Coagulase-positive staphylococci have also been encountered in about 30% of the fillets examined. These results accord with existing information about the incidence of food poisoning caused by fish and fishery products, which confirms that fresh fish is one of the safest articles of diet in Britain.

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