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Home Sweet Home? A.G. Huntsman and the Homing Behaviour of Canadian Atlantic Salmon

IN THE 1930S THE ATLANTIC SALMON became the object of a heated trans-Atlantic debate concerning the existence of racial stocks of salmon, and the questions of whether salmon migrated far out to sea, and whether or not they returned to the streams in which they were spawned. This double controversy illustrates the different ways in which scientists holding opposing views can interpret the same data. In this case, the sources of those views may be found in the scientists' previous research experience, in their receptivity to common wisdom, and perhaps also to theoretical trends not only in biology, but also anthropology and eugenics. By virtue of the fact that Atlantic salmon had already been eliminated, through human activity, from the streams of most of the rest of North America, Canadian fisheries biologists were prominent in studying Maritime salmon. The chief of these researchers was Archibald Gowanlock Huntsman (1883-1973), whose unorthodox theories, which denied the existence of races and homing in salmon, sparked the debates.[1]

Although Huntsman's most important work was based in the Atlantic provinces, he was not a Maritimer. Born in Tintern, Ontario in 1883, he received his Bachelor of Arts degree from the University of Toronto in 1905, where in 1907 he also received his Bachelor of Medicine degree. He was never to practice medicine; instead, while still a student, he became enamoured of biological research. From 1905 onwards he spent his summers as a student researcher at each of the new Canadian marine and aquatic field stations, located at St. Andrews, New Brunswick, Nanaimo, British Columbia, and at Go Home River on Ontario's Georgian Bay. His involvement with the Biological Board of Canada, which ran these stations, deepened, so that by 1911 he was curator of the St. Andrews Biological Station. He continued as curator until 1919, when he became the Station's director, a position he held until 1934. He also held the directorship of the Fisheries Experimental Station in Halifax from its inception in 1924 until his over-heavy burden of duties forced him to resign in 1928. He was also a lecturer

1 Printed history, in the form of Kenneth Johnstone's chronicling of the Fisheries Research Board of Canada, has not dealt kindly with Huntsman's legacy to salmon research; he is easily portrayed as a crank, but such may be the fate of many solid scientists whose theories do not prevail, yet whose science is not at fault. See Kenneth Johnstone, *The Aquatic Explorers: A History of the Fisheries Research Board of Canada* (Toronto, 1977), esp. pp. 140-3 and 304-6.

from 1907 to 1917 in the Department of Zoology at the University of Toronto, then associate professor, and after 1927 honourary professor of marine zoology. Although he no longer received a salary after 1916 from the University of Toronto, but was paid by the Federal Government through the Biological Board of Canada, for many years he combined fisheries research with post-graduate teaching, and "a majority of the Canadian fisheries biologists educated in the 1920s and 1930s were, at some stage, his students".[2] His dual occupations conferred an advantage upon him in an era in which Canadian marine stations only operated in the summer, because he could take his research materials back to the University of Toronto during term time and continue working. He retired from the Fisheries Research Board (the new name of the Biological Board after 1937) in 1953, and from his position at the University of Toronto in 1954.

Up until 1931 Huntsman's research interests were varied and eclectic. His earliest work had involved the systematics and distribution of ascidians, or sea-squirts, which were phytogenetically important because of their intermediate position between invertebrates and vertebrates. He participated in the Canadian Fisheries Expedition (1914-1915) to the Gulf of St. Lawrence led by the world's foremost fisheries biologist, Johan Hjort, to see if the herring populations of the western Atlantic had similar year-class compositions to those of the eastern Atlantic and the North Sea. Huntsman's participation in this expedition turned his interests toward fish population dynamics, marine ecology, and the distribution of marine animals. In 1918, he demonstrated graphically that fishing effort reduces the mean age of the fish in a stock, a finding more usually attributed to Russian scientist Theodore I. Baranov in the same year, and which was later to form the biological basis of fisheries management under the concept of the "maximum sustainable yield".[3] After the Canadian Fisheries Expedition, Huntsman's work was motivated by the belief that fisheries biology should be directed toward solving fisheries' problems. Thus, he organized or participated in a series of other expeditions investigating the distribution of commercially important species, and the oceanographic and biological factors limiting their distributions. He thought that limiting factors provided clues to the why of the distribution and abundance of the organisms in the Atlantic waters of Canada.[4] Once caught, fishes and shellfish had to be properly preserved in order to be competitive with non-fish products in inland markets. The Canadian Atlantic fishery in particular suffered from a poor

2 A.W.H. Needler, "Archibald Gowanlock Huntsman: 1883-1973", *Proceedings of the Royal Society of Canada*, Ser. IV, 13 (1975), pp. ??

3 J.L. McHugh, "Trends in Fishery Research", in Norman G. Benson, ed., *A Century of Fisheries in North America* (Washington, D.C., 1970), pp. 38-40.

4 A.G. Huntsman, "The Comparative Thanatology of Marine Animals", *Transactions of the Royal Society of Canada*, Ser. III, 20 (1926): Section 5, p. 187.

reputation for its products.[5] As director of the Halifax Fisheries Experimental Station, Huntsman made many technical contributions to improve frozen, pickled, and smoked seafood products. He is best remembered for his 1927 invention of jacketed cold storage. By building a jacket of refrigerating pipes circulating cold air around instead of inside the cold storage room, Huntsman reduced the dehydration effect and concomitant degradation in the quality of the frozen fish to 1/7th of that found in conventional cold storage rooms. This was, however, an invention ahead of its time: the use of jacketed cold storage took about 25 years to catch on in the fishing industry, despite its demonstrated superiority to other refrigeration methods.[6]

In 1927, Huntsman was galvanized into action by the fear that the proposed Passamaquoddy Power Project would devastate the lucrative Bay of Fundy herring fishery. During the 1920s and early 1930s he led research efforts investigating the herring of the Bay of Fundy and his publication, *The Passamaquoddy Bay Power Project and its Effects on the Fisheries* (Saint John, 1928), sparked popular concern over the ecological consequences of the proposed damming of the entrances of the Passamaquoddy Bay to harness tidal power. Huntsman instigated the International Passamaquoddy Fisheries Commission of 1931-2, which drew scientists from all over Europe and North America to investigate the conditions surrounding the Bay of Fundy and Passamaquoddy Bay. The Commission confirmed Huntsman's prediction that the building of dams would wipe out the inner Passamaquoddy herring, but disagreed with his idea that the dams would also dramatically alter the Bay of Fundy's water stratification and climatology, and thus the biota and fisheries of the bay.[7]

From herring studies Huntsman moved on to investigate the Atlantic salmon. From 1928 until his death, he worked on problems of salmon management, dealing with the practical challenge of trying to provide enough salmon for angling.[8] Burning questions in the early 1930s were whether Atlantic salmon

5 See Jennifer Hubbard, "The Commission of Conservation and the Canadian Atlantic Fisheries", *scientia canadensis*, 12 (1988), pp. 22-52.

6 See Johnstone, *The Aquatic Explorers*, pp. 125, 157-9. In 1931-32, Otto C. Young, an engineer working out of the Pacific Biological Station, was to conduct further research on jacketed cold storage, using Huntsman's "marvellous" principle, but applying his own considerable engineering expertise. He used the jacketed cold storage principle to revise the methods of refrigeration on railway cars, but it took a long time for jacketed cold storage to catch on in the refrigeration industry. Ironically, when the process finally caught on and was developed in the fishing industry 25 years later, the people of the Atlantic coast got the impression that it had been invented in British Columbia, when actually "It had been developed in their own backyards there in Halifax", as Huntsman recalled in 1973. Interview with A.G. Huntsman (Interviewer: Elizabeth Wilson), 3 May 1973, Part of the Oral History Programme at the University of Toronto Archives, Reading Room Finding Aid No. B74-0021, transcript p. 16.

7 Johnstone, *The Aquatic Explorers*, p. 144.

8 See A.G. Huntsman, "Fish (Salmon) Management", in the *Annual Report of the Fisheries*

were being overfished, and what caused the hugh fluctuations in the yearly catches. Salmon researchers from Scotland, Norway, and Canada, aided by avid anglers (some of whom conducted their own research), were investigating the comparative damage done to Atlantic salmon stocks by different fishing techniques. One of Huntsman's early triumphs was his explanation, in 1931, of the large natural component involved in fluctuating yearly catches, namely the fact that an abundant, successful year-class will effortlessly out-compete and even cannibalize following generations while still on the river, and will return in two to five years' time, depending on the cycle, to spawn another successful year class.[9] Since salmon tend to return to spawn as a year-class, stable but quite intricate patterns of alternating successful generations might result.[10] Huntsman and his chief assistant, Harley C. White, also showed that larger, periodic fluctuations in rainfall affected salmon abundance: dry years made the rivers run shallower so that deep-swimming salmon parr and smolts were more accessible to their predators, the mergansers and kingfishers. Large parr and smolts would suffer, but small parr and fry would benefit because the larger fish were no longer present to cannibalize them. Huntsman also experimented with artificial spates in streams with low water levels, tested the effects of removing predators from long stretches of river, and conducted the earliest salinity-tolerance experiment on salmon (in 1939), helped by his former graduate-student W.S. Hoar.[11] However, if his explanation for the fluctuations in salmon catches won Huntsman a reputation as a salmon expert, it was his work on salmon migration and his denial of the existence of different Atlantic salmon races that were to make him notorious and eventually to label him a crank on these issues.

Truly systematic studies of Atlantic salmon were begun only in the 20th century. Salmon provided an unusual instance in which the offshore fisheries had little to offer by way of information on the life-history of a commercial species. If, by some rare chance, salmon were caught in a trawl, it was only one or

Research Board of Canada for 1949 (Ottawa, 1950), pp. 41-3; *for 1950* (Ottawa, 1951), pp. 62-6; *for 1951* (Ottawa, 1952), pp. 100-3; and *for 1952* (Ottawa, 1953), pp. 129-36.

9 See A.G. Huntsman, *The Maritime Salmon of Canada, Biological Board of Canada, Bulletin No. 21* (Ottawa, 1931), pp. 1-99.

10 This also explained the major salmon-run which occurred on the Fraser River in British Columbia every four years prior to the fall of rock which blocked Devil's Gate during construction of the Canadian Northern Railway. Later attempts to explain the phenomenon were along the lines of the mechanism Huntsman had postulated for Atlantic salmon. See Johnstone, *The Aquatic Explorers*, p. 149.

11 Salmon from different developmental stages, from alevin to smolts, were exposed to different strengths of sea-water by being directly transferred from fresh water. The survival rate after a certain amount of time had elapsed provided an indication of various salmon stages' differential tolerance to salinity. See A.D. Hasler and A.T. Scholz, *Olfactory Imprinting and Homing in Salmon* (New York, 1983), p. 50.

two at a time. Biologists could only speculate about salmon swimming and feeding behaviour, the depths in which they swam, and their destinations once they had left their home-rivers. Beside direct observation, so difficult to achieve, there are two important means of obtaining information about the movements of salmon. The first is to mark or tag a number of fish at a given stage of their life-cycle, return them to the water, and record when and where they are recaptured. This was done by a few inquiring anglers in 19th-century Scotland, and gave the first accurate information about the length of time spent by individual fish in the sea, and about the great increases in their weight during this period.[12] The second technique is to examine salmon scales, compare them with the scales of fish from other localities, and by analyzing their growth rings determine their age, the amount of time spent in the river, and later in the sea, and whether they have returned to rivers to spawn once, twice, or more, and the time spent in the sea between the returns.

In the first half of the 20th century, much was done to characterise the different stocks of salmon from different rivers and countries. Knut Dahl, the Norwegian biologist who introduced scale-ring counting techniques to the study of salmon in 1905, attacked the question of whether different salmon stocks amounted to different races. He and many others found differing life-cycle patterns in salmon stocks from each separate river system. Some rivers have runs of salmon that have spent only a year in the sea, while others characteristically have runs of salmon that have averaged anywhere from three to seven years in the sea before returning to spawn. In Scotland, these questions also intrigued William L. Calderwood, the Inspector of Fisheries for Scotland, and his successor, William J.M. Menzies. Calderwood pioneered systematic examinations of the distances and speeds salmon travel in the sea, which were later carried on by Dahl, Menzies, and Huntsman.

Huntsman became interested in salmon problems following the 1928 Royal Commission on the Maritime Fisheries. In 1931 he published an analysis of salmon-tagging results gathered by the Department of Fisheries' Fish Culture Branch between 1913 and 1929. Huntsman noticed that, after spawning, the salmon of rivers possessing great estuaries, such as the Saint John, Restigouche, and Miramichi, showed little spreading or straying away from the estuaries' influence. According to Huntsman, the Saint John River salmon, at least, would encounter an abundance of herring and other food species even if they went no further than Point Lepreau, New Brunswick. Huntsman reasoned that their rare capture in this area could be accounted for by the fact that not two of the approximately 50,000 fish annually caught need be closer to each other than three-quarters of a mile or more in a layer of water five feet deep. On the other hand, the

12 William L. Calderwood, *The Life of the Salmon* (London, 1908), p. 12.

Margaree River of Cape Breton has virtually no estuary, and the salmon of this river showed considerable spread and what Huntsman called "straying" — one was captured at Twillingate on the south coast of Newfoundland three years later. Huntsman reasoned that wide scattering was a consequence of a scarcity of food, or of extreme temperatures. From his findings he argued that "there seems to be no reason for postulating distant migrations, until facts cause us to do so".[13] Over the next 15 years or so Huntsman orchestrated a series of salmon-tagging experiments on many different Maritime rivers, and the results never caused Huntsman to revise his opinion. After 1937 he presented his results, emphasising the importance of water movements in determining the travels of salmon, to strengthen and reiterate his earlier conclusions about the significance of zones of influence at the mouths of rivers. Huntsman concluded that the extent to which salmon kelts (salmon which have just spawned) "pass seaward beyond the influence of the river depends upon the degree and permanence of that influence". He did not doubt that salmon occasionally went to very distant places, and cited some cases of Annapolis, Miramichi, Morell, Philip, and Margaree river salmon which were recaptured off the east coast of Newfoundland. What Huntsman questioned was whether such fish returned, and whether such movements were deliberate. Distant recaptures of marked salmon varied greatly in location from year to year; if in any one year the salmon from different rivers were found in the same distant place, Huntsman attributed it to pronounced water movements "of unusual character" and argued that "Facts show that salmon are determined in their distribution by mass movements of water. Those that have been demonstrated by current measurements, by hydrographic methods, and by drift bottle experiments are sufficient to account for much of the peculiarity that is shown".[14] He assumed that it was safe to guess that the farther the salmon go the less is the likelihood of their return.

Huntsman likened the common belief in the migration of salmon to the old belief that the earth was flat and that the sun revolved around the earth.[15] This comparison was hardly calculated to endear Huntsman to the foremost European authorities on the sea-movements of Atlantic salmon: Knut Dahl of Norway and William J.M. Menzies of Scotland. Since 1913, under the supervision of William L. Calderwood and, after 1936, of his successor, Menzies, the Scottish had sporadically undertaken experimental tagging of salmon to trace salmon

13 Huntsman, "The Maritime Salmon of Canada", pp. 96, 99, 95.

14 A.G. Huntsman, "Sea Movements of Canadian Atlantic Salmon Kelts", *Journal of the Fisheries Research Board of Canada*, 4 (1938), pp. 131-5.

15 A.G. Huntsman, "Migration and Conservation of Atlantic Salmon for Canada's Maritime Provinces", *American Association for the Advancement of Science, Publication No. 8* (1939), p. 32.

movements and rate of travel in the sea. The Scottish scientists undertook these studies of their own volition, but in Norway in 1935 Dahl commenced his investigations into the sea-life and migration of salmon in response to a widespread petition by fishermen. It was felt that if the life-cycle and migrations were better understood, biologists and fishermen would have some ability to predict good and poor catches, find better areas for fishing, or perhaps pursue legal measures if salmon originating in one country was being harvested elsewhere. At any rate, it was hoped that there would be some measure of control over the uncertain and fluctuating catches.

Evidence for long-distance migrations was abundant. In 1935 Dahl and his assistant Sven Sϕmme marked and released salmon on the west coast of Norway, and found that the majority of fish travelled between 100 and 400 kilometres before they were recaptured. While these distances are not so very great, one salmon was recaptured, 52 days after it was tagged, at Wyg in East Karelin, in the White Sea's Gulf of Onega — 2500 kilometres away. Dahl and Sϕmme assumed that the distant places of recapture, such as Wyg, marked the home-points for salmon migrations. According to them, the findings that salmon were capable of "enormous speed and endurance" removed doubts about the possibility of regular long-distance migrations.[16] In addition, Dahl reported the capture in Norway of salmon marked by Menzies in Scotland, while Menzies announced that salmon marked in Norway were recaptured in Scotland.

Menzies was convinced that salmon migrate great distances even before he had gathered much experimental evidence. In 1925 he commented: "Where, or even in what direction, they go we are totally ignorant: it may be to the Dogger Bank, or the edge of the continental shelf out in the Atlantic, or the Arctic Ocean. It is certain that they go either to an unfished part of the ocean, or adopt a mode of life which leaves them almost entirely unaffected by all modern means of capture".[17] As he reasoned later, the feeding ground had to be located at some considerable distance, because nowhere close to Britain did the extensive fisheries catch enough salmon "to suggest anything like a congregation of growing fish gathered together in a selected feeding area".[18] However, the evidence was purely circumstantial. Menzies' marking experiments from the early 1920s showed that those salmon which travelled the greatest distances seemed to do so

16 Knut Dahl and Sven Sϕmme, "Experiments in Salmon Marking min Norway 1935", *Skrifter Utgitt av Det Norske Videnskaps-akademi Oslo, Nat. -Nat Kl. 1935*, No. 12 (1936), pp. 16, 20.

17 William J. Menzies, *The Salmon, Its Life Story* (Edinburgh, 1925), p. 136.

18 William J.M. Menzies, "Some Preliminary Observations on the Migration of Salmon (*Salmo salar*) on the Coasts of Scotland", *Conseil Permanent International pour l'Exploration de la Mer, Rapports et Procès Verbaux*, 108 (1938), p. 33.

at the fastest rates: one salmon travelled 250 miles at a rate of 35 miles a day. The point is that salmon might not always be moving so "purposefully", and so recaptures might not indicate much movement all the time, but when they do migrate, salmon can cross great distances with comparative ease, as indicated by their high speeds of travel. Further evidence came from salmon-tagging experiments conducted on the north-west coast of Scotland in 1936. Menzies selected a location here because he thought that fish travelling south from a feeding ground located to the north or north-west might first hit the north-west coast of Scotland on the way to their home rivers. He gained more sophisticated results than had been achieved previously from marking kelts or smolts in or near rivers, by marking salmon at a point where there were no rivers or estuaries, so that the salmon might be assumed to be in mid-migration. The majority of fish made considerable journeys before being recaptured. The evidence indicated that these marked salmon were on their way from feeding grounds to fresh water when they were netted. Their stomachs and intestines were nearly empty, as they had finished feeding and commenced fasting prior to spawning. All marked fish recaptured during the following year showed "quite unmistakable evidence of having spawned in the interval".[19]

As early as 1939, and with no more evidence than this and the direction followed by salmon striking the north-west coast of Scotland and then proceeding down the coast, Menzies surmised that salmon from Norway and the East coast of Scotland had a feeding ground near Iceland: "a station on the South West coast of Iceland might be well-justified". However, Menzies feared that success in locating these feeding grounds "might lead to such commercial exploitation as to be highly inimical to the fishery generally".[20] Menzies surmised, from their different growth rates, that salmon from the west coast of Scotland had a more westerly destination. These were masterly guesses, and in 1957, Menzies had the felicity of announcing in *Nature* that a salmon, tagged in Scotland, had been re-tagged, not on the south-west coast of Iceland, but rather on the coast of that more distant island, Greenland. The fish had travelled a straight distance of 1,730 miles, and Menzies saw in the recapture the solution to his long-hypothesised north-western feeding ground.[21] Unfortunately, his fears that commercial exploitation of these grounds would follow their discovery were also to be realised.

Until 1937, Menzies and Dahl and Sømme were willing to allow that hydrographic movements and other external factors might influence certain migra-

19 Menzies, *The Salmon: Its Life Story*, pp. 177-8; and "Preliminary Observations", p. 33.

20 William J.M. Menzies, "The Present and Future Stages of Salmon Research in Scotland", *Conseil Permanent International pour l'Exploration de la Mer, Rapports et Procès Verbaux*, 109 (1939), p. 132.

21 William J.M. Menzies, "Long-Distance Migration of Salmon", *Nature*, 179 (1957), p. 790.

tions. In 1938, however, Dahl and Menzies both published reports which came down strongly against the view that migrations were affected by oceanographic currents. Menzies was willing to accord hydrographic effects a small role, as salmon, when travelling close to the shore, were observed to swim temporarily with the tidal stream or with eddies, but he insisted this was "a purely local effect and has no relation to the main run of fish along a larger section of the coast".[22]

Since the transition in their views came quite suddenly, some event must have caused them to revise their opinions and strengthen their thesis concerning active salmon migration. In fact, Huntsman had provided the catalyst. In 1937, he had published two articles in *Science*, refuting the theory that Atlantic salmon migrations over long distances were commonplace, and equally denying that salmon always return to the stream in which they were spawned, and that each stream possesses a different race of salmon. Since Huntsman had observed and experimentally shown that smolts and kelts lingered near the Saint John and other large-estuaried rivers in the Maritime provinces, he concluded that salmon which somehow randomly wandered far from the zones of rivers' influence (and these were rare) could be said to be "lost". These articles provoked widespread controversy, and almost certainly caused Dahl and Menzies to harden their positions against any theories that sought to refute the importance of active salmon migrations.

A part of the reason for the controversy was the very different ways the data were interpreted by Huntsman and by Calderwood, Menzies, and Dahl. Menzies and Dahl followed Calderwood, who wrote in 1930 that salmon "can rove hundreds and hundreds of miles off the coast, as they follow the creatures on which they feed. Instead of regarding...chance distant recaptures as telling us little or nothing, I am inclined to regard them as valuable indications of where salmon go in the sea".[23] Huntsman, by contrast, regarded the distant recaptures of marked salmon, which were in the order of one or two per cent of the total recaptures of marked fish, as the exceptions to the rule.

Having studied the motion of currents using drift bottles in 1924, Huntsman was convinced that ocean currents provided a sufficient explanation for salmon movements. Motivated by the ridicule his theory received, he undertook further investigations concerning salmon movements relative to currents. He showed experimentally in 1943 that while sharp freshets during low river levels induced salmon milling around the river's mouth to move upriver, heavy floods had the opposite effect, carrying marked kelts seaward. In other words, the salmon trying to move upriver to spawn either could not overcome or else failed to fight against the very strong currents. Also, tagging results persuaded Huntsman

22 Menzies, "Preliminary Observations", p. 19.

23 William L. Calderwood, *Salmon and Sea Trout* (London, 1930), p. 20.

more strongly than ever that, except for a few salmon that travelled enormous distances, "salmon in the sea go to and fro to a considerable extent". Salmon that became caught in currents in deep water would be carried along because "there is no evidence that they will swim against a current unless they are in relation to the bottom, through touch, sight, and possibly turbulence". Salmon keep near the surface, in which currents may be set up by winds. Because the prevailing Maritime summer winds come from the south-west, Huntsman explained the north-easterly movement of tagged salmon captured in distant places such as Newfoundland as a result of these wind-generated currents. Further evidence that salmon did not usually leave the zones of influence of the deeper, stronger rivers such as the Saint John came from the results of the Quebec Salmon Commission tagging experiments. These salmon were never recaptured outside the zone of influence of the St. Lawrence River outflow.[24]

While Huntsman's theory had few adherents, the more attractive theory of long salmon migrations to distant feeding-grounds had a large, enthusiastic following, perhaps because of the rather romantic image of salmon purposefully travelling great distances and undergoing great trials finally to return, years later, to their home streams to spawn. Fisheries biologists who opposed Huntsman had the fishermen on their side; the fishermen had long maintained that their inability to catch salmon in the sea was due to the salmon being in some distant, unknown location. Support for this idea strengthened with the discovery of the Greenland feeding grounds, and seemed unassailable when overfishing off Greenland in the late 1960s coincided with disastrous catches in Canada and Europe. Obviously, the poor catches here were caused by the over-exploitation of salmon in Greenland waters by international fleets. Further, in the mid-sixties, the Greenland salmon themselves were tagged and subsequently recaptured in Canadian, Irish, and Scottish waters, indicating that the salmon found near Greenland were not all only indigenous to that island. In the face of this evidence, Huntsman continued to hold that the number of Canadian or other salmon which migrated to Greenland was insignificant. He found a correlation between the poor catches of the late 1960s and low water levels on the rivers. For supporting evidence he cited S.A. Horsted, who reported in 1971 that of 1,818 salmon tagged in Greenland that year, nearly 72 per cent of the total number of recaptures occurred in Greenland, while only 11 per cent were retaken in Canadian waters. Similarly, of the smolts tagged on the Miramichi, P.F. Elson reported that only about 11 per cent of the recaptures were in Greenland, while of the remaining fish recaptured in Canadian waters, 91 per cent were in the river and its outflow. Five per cent of the recaptures occurred in the Saint John River.[25]

24 A.G. Huntsman, "Migration of the salmon in the Sea", *Salmon and Trout Magazine*, 123 (May 1948), pp. 155, 157-8.

25 A.G. Huntsman, "The Truth About Salmon Fishing" (1973?), pp. 459, 460. Huntsman cites these

Other researchers were equally certain that this kind of data supported their own belief in salmon migrations to Greenland, and these researchers then moved on to tackle other scientific questions based on this assumption. Clearly, Huntsman and his few sympathizers viewed the significance of a few distant recaptures in a very different light from the followers of the more successful theory. Tagging experiments at best give returns in the order of 15 per cent, and frequently the returns are not that good. Of this number, as Huntsman always pointed out, the distant recaptures were very few. In 1971, near the end of Huntsman's life, salmon expert Derek Mills had to admit that much was still unknown about salmon movements.[26] This is a classic case in which scientific theories had to be inferred from evidence that was primarily circumstantial, and did not conclusively favour one theory or the other, especially before Menzies' discovery of the Greenland feeding grounds. In the absence of hard evidence, the fervour with which Menzies searched for his hypothesised distant feeding ground, and the stubbornness with which Huntsman defended his own theory, indicate a case in which scientific theory-making was influenced by indirect or even non-scientific factors. In other words, these scientists were bringing previous biases to their assessment of the data.

What were the sources of these biases? In the cases of Menzies, Calderwood and Dahl, and the majority of salmon biologists, the matter seems fairly simple. They were following an accepted tradition, upheld by generations of fishermen to account for the lack of salmon in their inshore and offshore catches. According to the fishermen, the salmon must have gone somewhere else; there was no other way these fish could so successfully elude capture. The tradition was strong, and until Huntsman came along, there seemed to be no reason to question it, especially since salmon had been proved experimentally to be capable of travelling long distances in short periods. Huntsman's analysis of his opponents' stance probably also captured a fragment of their underlying, unconscious motives; he noted that their theory was more fulfilling of human anthropomorphic projections, giving the Atlantic salmon the attribute of intelligence to accomplish "long and precise migrations".[27] It is undeniable that such a picture is rather more captivating than his image of salmon milling around in "mindless" pursuit of prey in the Bay of Fundy. Certainly, the pursuit of evidence to support common lore proved fruitful for Menzies. His faith was based on little data in 1925; yet 32 years later

authors in this article, of which a reproduction can be found in the A.G. Huntsman Aquatic Reference Library, in the Ramsay Wright Zoological Building at the University of Toronto. The article gives no indication as to the journal in which it was published.

26 Derek Mills, *Salmon and Sea Trout: A resource, its ecology, conservation and management* (Edinburgh, 1971), pp. 79-83.

27 A.G. Huntsman, "Sea Behaviour in Salmon: The Case Against an Hereditary Homing Instinct", *Salmon and Trout Magazine*, 90 (March 1938), p. 24.

he had built up a theoretical edifice with ever more impressive evidence, the pinnacle of which was provided by his discovery of the Greenland feeding grounds, which he deduced to be the destination of all west-coast Scottish salmon from the discovery of but one tagged salmon captured there.

The sources for Huntsman's denial of all this (although he never questioned the "facts" of these distant recaptures) are not quite so clear. Certainly, personality was one factor. Huntsman's scepticism and love of argumentation are well-remembered by his students and younger colleagues, and are well-documented.[28] In this spirit he challenged many accepted beliefs and practices, and usually came up with alternate proposals of his own. But Huntsman also came to this debate armed with prior prejudices. One of these prejudices was his philosophical belief that human and animal behaviour could be explained by what he termed "biapocrisis". Huntsman invented this word, which comes from the Greek words for "life" and "response", to signify "the response of the organism as a whole to what it faces where it lives". He argued that because we are unable to account for an animal's behaviour by inferring its subjective experience, which we cannot understand, we should adopt the objective standpoint taken by physiologists, and explain the behaviour of organisms by locating the immediate environmental stimulus to which they are responding.[29] In addition to these beliefs, however, Huntsman also had a prior prejudice about the importance of currents to fish-movements. A letter to Huntsman from William Bell Dawson, Superintendent of Tidal Surveys, dated 11 March 1916, indicates that Huntsman was already either impressed or convinced by some remark Dawson had made 20 years earlier,[30] to the effect that there was a relationship between currents, temperatures, and the movements of fish. This statement was made, according to Dawson, before any biological investigations had looked into the matter, and Dawson's letter suggests that such investigations had only begun quite recently. What is not clear is whether Huntsman had seen in Dawson's remark merely a corroboration of his own beliefs, or whether Dawson somehow sparked a new direction of thought for Huntsman. Be that as it may, Huntsman's fascination with the significance of currents was to lead to his involvement on a project begun in 1921 by the North American Council on Fishery Investigations, to gain exact knowledge regarding western North Atlantic ocean currents. Together with Henry B. Bigelow, later the founding director of the Woods Hole Oceanographic Institute, he headed a Council sub-committee, cooperatively

28 See Needler, "Archibald Gowanlock Huntsman, 1883-1973", and Johnstone, *The Aquatic Explorers*, which makes frequent references to Huntsman's qualities.

29 A.G. Huntsman, "Method in Ecology — Biapocrisis", *Ecology*, 29 (January 1948), p. 30.

30 Huntsman Collection, Accession B78-0010/0009, File 11, the University of Toronto Archives. The letter does not name the publication in which Dawson made these comments.

aided by the United States, Canada, Newfoundland, and France, to carry out and interpret extensive drift-bottle experiments between 1922 and 1933. Oceanic currents were selected for study because, according to the council, they had an "outstanding importance in determining the fisheries of any particular locality".[31] It is obvious, then, that Huntsman had a commitment to the significance of oceanographic factors long before he came to the study of salmon. With evidence nearly as scanty as that which upheld the beliefs of the "salmon migrationists", his theory owed as much to prior prejudices as did theirs.

Another scientific debate which also owed much to external influences quickly followed. The question of salmon migration only served to warm up the arguments that were to rage over the next five years. A few months after his 1937 publication in *Science* on salmon migration, Huntsman published an equally inflammatory article questioning the phenomena of races and homing behaviour in salmon. Ensuing publications were to win him the disfavour of his colleagues, because he insisted that the populations of salmon in each different river did not consist of distinct races, and that homing, since it did not occur, could not possibly be the mechanism which kept these populations separate, by safeguarding the genetic integrity of the "races". Since Huntsman was trampling on two of the most basic tenets of salmon research, it is hardly surprising that his articles provoked an outroar.

The belief that salmon home is an old one. According to Knut Dahl, it arose from, and was supported by "the fact that the salmon from various rivers often exhibit quite striking differences in appearance and also in size.... These facts have long been known and observed upon by fishermen". Dahl himself directed much of his work to distinguishing different salmon races. He made comparative studies of the salmon of Norway in 1912, and later of Icelandic salmon, which showed enormous differences in salmon from different rivers "in point of age, growth, and duration of life". Dahl claimed that similar investigations in England by Hutton, in Scotland by Menzies, and in Sweden by Alm, all tended "to confirm the idea, that the salmon of various rivers must be considered as peculiar biological types or units, upheld by the homing instinct inherent in the young".[32] Thus, the questions of homing and races in salmon were inextricably intertwined. And yet, as Huntsman was to highlight, the argument was tenuous, since the evidence was susceptible to more than one interpretation, and indeed did not even support the idea of separate races. For example, although Calderwood was convinced that different Atlantic salmon races existed, he had to admit in 1930 that

31 *North American Council on Fishery Investigations. Proceedings 1921-1930*, No. 1 (Ottawa, 1932), p. 27.

32 Dahl and Sømme, "Experiments in Salmon-Marking in Norway, 1935", pp. 6, 7.

> the Fishery Board for Scotland in their various investigations have not obtained very conclusive evidence of the existence of local races amongst salmon. They have taken an infinite amount of trouble to measure fish and to measure scales, and to follow out the whole cycle of life in the fish of several rivers and to compare one river with another, but this method has been inconclusive.[33]

Nevertheless, Menzies, like Calderwood, remained convinced that salmon races exist and are preserved by homing. If a marked salmon was recaptured in a river other than the one in which it was tagged, "it would seem to be that the salmon lost its way, as it were". Such lost salmon were to be regarded as "altogether exceptional and mysterious occurrences". He chose to interpret the scattering of salmon as indicating "the ease with which the salmon may cover many miles". The great distances covered "show the *desire* of each fish to enter not merely any river, but to make for its own native stream, whatever distance that stream may be from the part of the coast first approached on the return of the fish from the feeding grounds".[34]

Huntsman found such speculations distastefully anthropomorphic, and had a very different interpretation of his accumulating Maritime salmon-tagging results. In 1934 he wrote that "rivers exhibit great differences in degree of perfection in [guiding salmon].... Although the salmon, if given time, is fairly certain to find some stream into which to run, the return to fresh water may be delayed very considerably". The Saint John River exhibited "very perfect control" over its salmon, due to its large volume of water and "its storage in a very extensive reservoir inside the Reversing Falls at the river mouth, so that there is a comparatively large and regular discharge into the sea".[35] Saint John River salmon tagged and released near the Reversing Falls were all recaptured nearby or in the river itself, and none ever strayed to another river system. This pattern was in marked contrast to that of the Margaree River of western Cape Breton Island, with its "fitful discharge of water". In Huntsman's opinion, such a river could only exert a very limited control. Tagged Margaree salmon were recaptured not only in the river and its vicinity, but from 85 miles to the south-west and 115 miles north-eastward around the northern part of the island, as well as at more distant points on the coasts of Newfoundland and Labrador. Huntsman was of the opinion that "quite a considerable portion of this stock, particularly of the older and larger fish, are altogether lost to the river through passing beyond its

33 Calderwood, *Salmon and Sea Trout*, p. 43.

34 Menzies, *The Salmon, Its Life Story*, pp. 147, 148, 171.

35 A.G. Huntsman, "Factors Influencing Return of Salmon from the Sea", *Transactions of the American Fisheries Society*, 64 (1939), p. 352.

influence".[36] If the salmon of the Saint John River never strayed from the zone of that river's influence, then their re-ascent of it to spawn hardly constituted "homing". Equally, argued Huntsman, there was no evidence that the fish which strayed from the zone of influence of a weaker river such as the Margaree ever returned.

As Huntsman pointed out, many factors influenced the ascent of a river by a salmon. Menzies had observed that in dry weather, grilse in tidal waters moved up the estuary just ahead of the tide, and fell back with the tide during the ebb. However, during a spate, or freshet, the tidal movements were ignored; the salmon moved up the estuary and rapidly swam upstream. Menzies also found that until the water warmed to 42 degrees Fahrenheit in the spring, there was little upriver movement of salmon over obstacles.[37] Taken together, all these factors apparently so important to ensuring the return of salmon to their home streams convinced Huntsman that there was more to the picture than the common idea of salmon purposively navigating the seas to the river of their birth.

In 1938, Huntsman published an article in which he brought widespread attention to an ongoing experiment which he had directed Harley C. White of the Biological Board to begin around 1930. This experiment involved the transferring of salmon fry from the Restigouche River to the East Apple River in Nova Scotia, a river denuded of its indigenous salmon by a 19th-century dam, which had since disintegrated. The descending salmon smolts were enumerated and marked, and the returning fish were only monitored on the East and West arms of the Apple River, so that there was no means of knowing if any of the marked fish entered any of the other streams near the Apple River. What Huntsman and White found was that the returning marked fish, although of Restigouche stock, behaved like Apple River salmon. Restigouche salmon spent three years in the river; these only spent two, like Apple River salmon. Restigouche salmon commonly spent two or three years in the sea, returning early in the season. The planted fry spent less than two years in the sea and returned, as grilse, predominantly in the autumn. In fact, Huntsman and White concluded that "the Restigouche salmon introduced into the Apple river could not be distinguished from the indigenous salmon, and hence failed to show any evidence of a 'Restigouche inheritance' ". To Huntsman and White this experiment demonstrated "that environmental conditions, acting on the individual from the fry stage on, made the full observed difference in behaviour between Restigouche and Apple river salmon".[38] If this was true, then the existence of races of *Salmo*

36 *Ibid.*, p. 353.

37 Mills, *Salmon and Sea Trout*, p. 82.

38 A.G. Huntsman and Harley C. White, "Is Local Behaviour in Salmon Heritable?", *Journal of the Fisheries Research Board of Canada*, 4 (1938), pp. 14, 16.

salar became entirely problematical. As for homing, the planted salmon, when they returned as grilse prior to October 22 in the fall of 1935, unerringly ascended the East Apple. Subsequently, however, more marked grilse were found ascending the West Apple than the East Apple. Huntsman concluded that "near spawning time the homing tendency was not so strong or was overpowered by other things".[39]

In 1937 Huntsman began his campaign to try to convince others that salmon behaviour was determined by external, environmental factors rather than by internal and hereditary, purposive, complex behaviours that smacked of anthropomorphism. He opened his attack in *Science* by taking exception to Calderwood's assumption that salmon returned to their home streams from distant places in the ocean "by a homing instinct which men cannot comprehend". Huntsman had failed to find a single clear case in all the literature in which a salmon was proved to have returned to its natal river from a distant place in the ocean. He required as proof a knowledge of the salmon's natal river and of where it had been in the sea, and evidence that it had returned to its natal river. Huntsman argued that without such information, "it seems pointless to speak of a homing instinct",[40] especially since there was definite evidence against a homing instinct because of the number of salmon marked in one river which had been recaptured in another river. Huntsman reiterated that, if salmon somehow strayed far from the zone of river influence, there was little likelihood their random wanderings would bring them back. Such "lost" salmon might reach neighbouring rivers or distant places in the sea, "their course in part determined by the movement of the water".[41]

One Pacific salmon researcher, Willis H. Rich, complained in the 14 May 1937 issue of *Science* that Huntsman was demanding "practically impossible evidence" for the homing of salmon. Such confirmation was not truly required because of the "ample evidence, both observational and statistical, of intraspecific racial segregation in the Pacific salmon". These races, Rich maintained, would not persist if the different population groups intermingled on the spawning grounds. Rich expressed the hope that Huntsman's article in *Science* had not affected the general acceptance of the theory, since "important practical problems in the conservation of the Pacific salmon are involved because laws and regulations have been based on the theory that the salmon do return to their home streams for spawning".[42] Huntsman had tilted at the windmill of an accepted yet unproved

39 A.G. Huntsman, "Return of Salmon from the Sea", *Biological Board of Canada, Bulletin No. 51* (Ottawa, 1936), p. 8.

40 A.G. Huntsman, " 'Migration' and 'Homing' of Salmon, *Science*", 85 (March 1937), p. 313.

41 *Ibid.*, pp. 313-4.

42 Willis H. Rich, " 'Homing' of Pacific Salmon", *Science*, 85 (May 1937), p. 478.

scientific paradigm, and the whole establishment trembled. Researchers on both sides of the Atlantic, and on the Canadian and American Pacific, leapt to the defense of the cherished cornerstone of salmon biology: the homing instinct.

Huntsman responded with a second article in *Science*, in which he pointed out that many of the "racial" characteristics in species of marine fish, such as the herring, were being discovered to result "from the action of the environment on an individual during its lifetime", and that such characteristics were of doubtful inheritability. In such cases, the use of the word race was valueless.[43] Calderwood now entered the fray on Rich's behalf. However, he skirted around Huntsman's question: "do these wandering salmon return to their natal rivers?" In his view,

> when we cannot get proof of an absolute kind, the practice is to fall back on a series of oft-repeated experiments. If these all point to the same conclusion, we are justified at last in forming the opinion that we have got the truth. And no attempts of another kind are likely to shake such a conclusion.... In the present case, Dr. Huntsman must overcome the accumulated evidence of about half a century.[44]

In the fall of 1937, *The Pacific Fisherman* published a serial article by a number of anonymous scientists, who also attempted to refute Huntsman. The authors argued that it was practically impossible to trace the movements of a salmon from its natal river to the sea and back again. They concentrated instead on circumstantial evidence that strongly indicated homing behaviour and the maintenance of separate races by this behaviour in each of the four species of Pacific salmon. Huntsman, of course, did not miss his chance to reply. The following February, he responded in *The Pacific Fisherman* that there was as yet no clear case of a salmon returning to its home river from a distant place in the sea: "While there is a general belief that they do so, this rests on evidence that in other hands might well be shown to have other possible interpretations.... Personally, I have no desire to disprove an unproved theory. I merely wish to call attention to the fact that it is unproved". The burden of proof lay on those who believed in this theory: he merely wished to get on with "trying to discover what the salmon actually do, whatever that may be".[45] In March 1938, Huntsman also responded to Calderwood. Before presenting his usual supported arguments,

43 A.G. Huntsman, " 'Races' and 'Homing' of Salmon", *Science*, 85 (June 1937), pp. 582-3.

44 W.L. Calderwood, "Homing Instinct in Salmon," *Salmon And Trout Magazine*, 88 (February 1937), p. 213.

45 A.G. Huntsman, "Return of Salmon to their Home Streams", *The Pacific Fisherman*, 36 (February 1938), p. 27.

Huntsman "confessed" that "I waited several years, considered the matter very carefully and discussed it with many people, before publicly declaring my scepticism. These theories have come to be so firmly believed that they almost constitute a 'religion' to many anglers, and one does not lightly choose the role of a heretic".[46] Huntsman claimed that at first he had felt no need to disturb those beliefs, but since they were determining government regulation of the fisheries and fish cultural practices, when officially asked, he made his conflicting views known.[47]

In disputing homing in salmon, Huntsman was flouting convention; in claiming that supposed inherited traits were environmentally caused variations, he was at once defying a deeply ingrained social bias regarding the idea of race, and riding a new wave of biological thinking. The study of races has been longest most evident in anthropology and ethnology, in which, at least in Britain, by 1850 human races were believed to be "stable and essential entities which caused or prevented the flowering of civilized behavior", not the "superficial and changeable products of climate and civilization".[48] Some scientific racists even rejected philanthropic efforts to educate and improve "inferior races" and missionary efforts to convert them because the immutability of racial categories proved the futility of such efforts: the target races were too stupid and morally moronic.[49] The extreme belief that human races were either separately created by God or, after Darwin's theory of natural selection was made public in 1859, evolved from separate ape species, was held by the polygenists; some ageing anthropologists still held these views in the 1930s. Less extreme racial scientists believed that human races had evolved from a single species so long ago as to form virtually distinct, immutable species. Within the evolutionary infrastructure, racial scientists maintained the fixity of racial differences by claiming that natural selection no longer acted on man's physical characteristics, only on his mental and moral nature, so that racial types could be treated as if they were fixed entities.[50] In anthropology, the goal was to construct the ideal type of each race, in spite of the mongrelism and mixing of modern races, which meant that no particular individual would have all the attributes of the ideal types. Meanwhile, in fisheries investigations, racial studies served a diagnostic function. In 1898, Friedrich Heincke pioneered racial investigations on fishes when he published a work on the natural history of the herring. Thereafter, "racial investigations"

46 A.G. Huntsman, "Sea Behaviour in Salmon: The Case Against an Hereditary Homing Instinct", *Salmon and Trout Magazine*, 90 (March 1939), p. 24.

47 *Ibid.*

48 Nancy Stepan, *The Idea of Race in Science: Great Britain 1800-1960* (London, 1982), p. 4.

49 Douglas A. Lorimer, *Colour, Class and the Victorians* (New York, 1978), p. 152.

50 Stepan, *The Idea of Race in Science*, pp. 45, 46, 85.

became very much the vogue in fisheries science. Heincke found no single measurement or feature of herring to distinguish "races", but discovered characteristic relationships between set measurements (length, weight, distances between fins, etc.) typifying different herring populations. From this he hypothesised races that not only lived in different parts of the sea, but did not interbreed. This enabled him to contradict the popular fisherman's assumption that catch fluctuations were caused by the random migrations of a common herring population.[51]

Throughout the latter third of the 19th century, and well into the 1920s, Darwin's theory of natural selction was held in doubt, and the role of the environment in selecting or eliminating certain variations in the struggle for survival was disputed. In anthropology, the monogenists, who believed that all human races belonged to the same species, and who stressed the importance of environmental influences in causing physiological differences between races, had encountered many problems in trying to maintain these views since the 1850s. For example, although they tried to correlate climate with skin colour, there were enough exceptions to make this theory hard to defend.[52] While Darwinism was in eclipse, two other ways of thinking about evolution came to the fore. One of these was sparked by the rediscovery of Mendelian genetics around 1900, was espoused by experimental biologists, and survived to be integrated into the evolutionary synthesis of the 1930s and 1940s. The other was Neo-Lamarckism, which held that evolution was caused by the inheritance of acquired characteristics; it lost most of its credibility by World War I.

Experimental biologists, inspired by the rediscovery of Mendelian genetics, denied that the environment forced adaptive changes and natural selection, claiming instead that mutations alone were responsible for evolutionary changes. They were unable to conceive how the environment could interact with genetic material to direct these changes. Mendelian genetics in turn provided a strong reinforcement for the "science" of eugenics, which was based on the belief that intellectual and physical differences between individuals and races were hereditary. Such modes of thought possibly influenced Huntsman's scientific adversaries' ideas about salmon populations. Human "races" are only a special case in biological racial studies, and until the 1930s and 1940s races in other species were commonly looked upon as products of inherited genetic mutations, not of environmentally-induced changes. Unfortunately, it is difficult to generalise about biological (as opposed to anthropological) racial studies of this era, in part because no detailed historical evaluation of this work exists. Further, it is a complicated issue because the term "race" has had so many meanings in the past, making it a vague

51 Margaret Deacon, *Scientists and the Sea 1660-1900* (New York, 1971), p. 220.

52 Stepan, *The Idea of Race in Science*, p. 89.

term even in anthropology. It has been used to designate anything from a fixed and separate species to individuals in a species possessing distinctive features, and in the 1930s, biometricians used the term to mean "a statistical statement about a population".[53] Huntsman and his scientific foes never bothered to define what they meant by "hereditary" races of salmon, and it was never specified what physical traits they were using to designate salmon racial types. However, these salmon experts had been educated and informed in an era in which eugenics was a strong movement and hereditarian beliefs prevailed, and it is hard to see how their opinions could not have been moulded by this intellectual and social climate. Huntsman had to fight not only the issue of salmon races itself, but the whole package of these cultural views.

Huntsman, on the other hand, had earlier been a follower of the more environmentalist school of evolutionary thinking, Neo-Lamarckism. Neo-Lamarckism tended to be championed by field-naturalists and paleontologists as a challenge to Darwinian theory. In America, Louis Agassiz's pupils theorised that "evolution proceeded by a series of additions to the growth of the individual" in the embryonic stages.[54] Neo-Lamarckism was attractive to people troubled by the theological and teleological implications of Darwinism; at the very least, it denied the purposelessness inherent in Darwinism by allowing organisms to be in charge of their own evolution. When encountering a new situation, animals first made a conscious response, which repeated exposure reduced first to habit, and finally to instinct. Physical changes to the body would eventually follow through the use-inheritance accompanying such behaviour. Huntsman was influenced by the distinctive American school of Neo-Lamarckism developed by paleobotanists Edward Drinker Cope and Alpheus Hyatt, and he invoked Cope's theories to explain some of the phenomena he encountered during his early studies of ascidians, which were mainly done prior to World War I. He thought that homologous organs in different organisms, such as the ganglion in ascidians and the main part of the brain in vertebrates, may have evolved in parallel. He also speculated that "the same species has arisen repeatedly and again by different paths", making it difficult to tell if a given species were more closely related to forms which it resembled, or in fact to a dissimilar form from which it evolved.[55] Such ideas reflected Cope's claims that each genus represented a group of species that had reached the same stage in their historical development — not necessarily of a common descent, but merely holding "an identical position in the scheme of development". The guiding force was environmental stimuli interacting with

53 *Ibid.*, p. 168.

54 Peter J. Bowler, *Evolution: The History of an Idea* (Berkeley, 1984), p. 244.

55 A.G. Huntsman, "The Ascidian Family Caesiridae", *Transactions of the Royal Society of Canada*, Ser. 3, 16 (1922), Section 5, pp. 212-4.

Lamarckian use-inheritance. Despite the Neo-Lamarckism's strength at the turn of the century, however, by 1914 it was quickly losing favour. It was crippled by a lack of experimental evidence at a time when experimental biology was surging in importance. In spite of this, paleontologists and field biologists still upheld some of the tenets of Neo-Lamarckism, and continued to hope for experimental evidence to strengthen their case. This caused a rift with the geneticists and experimental biologists "that was not healed until the emergence of the modern synthesis in the 1930s and 1940s".[56]

Since Neo-Lamarckism had mostly fallen into disrepute by 1920, this left the field of racial studies all the clearer for hereditarian theories. However, although these were to dominate in many areas of biology, anthropology and eugenics until World War II, new research after 1920 began to undermine the assumptions of naive hereditarianism. For example, research by Thomas Hunt Morgan and other prominent geneticists made it increasingly evident that simple one-gene inheritance of traits was not at work in most cases. There grew the realisation that a given phenotype — the physical expression of the genes — was not always guaranteed by breeding organisms with that phenotype. Polygenic inheritance ensured variations in traits such as height, skin colour and intelligence. Also, the influence of the environment on the genotype came to be recognised, as exemplified in Herbert S. Jennings' elegant experiments with genetically identical paramecia. He found that under different environmental conditions these paramecia developed diverse physical characteristics.[57] The leaders in genetics research, such as Morgan and H.J. Muller in the United States and J.B.S. Haldane and Lancelot Hogben in Britain, began to criticise the scientific assumptions which bolstered the eugenics movement in the mid-1920s, and this criticism began to emerge publicly in the early 1930s. Main-stream eugenics, with its hard-line stand on the importance of heredity, began to fade in the 1930s, and the implications of eugenics programs implemented by Nazi Germany dealt it a death-blow. However, many scientists continued to endorse some kind of eugenics. Huntsman himself was a member of the American Eugenics Society as late as 1939, but his membership, considering his environmentalist philosophy, need not necessarily appear anomalous. A kind of reform eugenics began to evolve in the late 1920s, mirroring developments in genetics. This progressive eugenics recognised the importance of nurture (environment) as well as nature (heredity), and was advocated by Julian Huxley, among others. Huxley recommended that basic environmental conditions, such as nutrition, housing, medical care, and opportunity, be equalised before genetic differences could be evaluated and eugenics programs implemented. In common with the socialists, progressive eugenics

56 Bowler, *Evolution*, pp. 247-8, 250.

57 Daniel Kevles, *In the Name of Eugenics* (New York, 1985), p. 143.

called for state intervention and social policy to achieve social improvement, in the form of family allowances as well as family planning.[58] However, even while progressive eugenists who were aware of recent developments in genetics were criticising mainstream eugenics, the eugenics philosophy remained intact. H.J. Muller and J.B.S. Haldane questioned the research methods and conclusions, but not the aim of eugenics,[59] and Huntsman was to follow suit.[60]

Huntsman was probably influenced by these changes in eugenics and in genetic theories, which strengthened his early commitment to the importance of the environment. It is equally probable that his opponents on the issue of salmon races — Calderwood, Menzies, Dahl, and the rest — were still firmly in the fold of hereditarian beliefs, since they lacked Huntsman's ecological perspective. Since Huntsman was deeply interested in population fluctuation cycles and other aspects of population biology,[61] he must have kept in touch with developments in this science, and especially the advent of population genetics. The latter was crucial to reestablishing Darwinian natural selection — and thus the role of the environment — to its central position in modern evolutionary theory during the evolutionary synthesis of the 1930s and 1940s. Population genetics emphasised the wide variety of genes for each trait which is present in the wild population, ready for selection to act upon. Study of animal populations in the wild was the province of field naturalists or ecologists, who could bring back to evolutionary thinking the environmental perspective it had lacked when evolutionary theory was dominated by geneticists, biometricians, and mathematicians. Further, for a long time ecologists and taxonomists had had to deal with the problem of whether the local species

58 Michael Freeden, "Eugenics and Progressive Thought: A Study in Ideological Affinity", *The Historical Journal*, 22 (1977), p. 666.

59 Garland Allen, "The Misuse of Biological Hierarchies: The American Eugenics Movement 1900-1940", *History and Philosophy of the Life Sciences*, 5 (1983), p. 199.

60 In a letter dated 27 April 1928, Huntsman wrote to the president of the American Eugenics Society, Dr. Ellsworth Huntington, asking "whether there is any evidence that the measures advocated are being effective". Huntsman Collection, Accession B78-0010/020, File 1, University of Toronto Archives.

61 Huntsman's analysis of the cyclic salmon population fluctuations in Maritime rivers provides an excellent example of one kind of work being done by population biologists. Huntsman displayed a far greater understanding of the roles of intraspecific and interspecific competition and the ways in which populations interact with environmental changes than any of the other Atlantic salmon experts, whose explanations of salmon population fluctuations were simplistic and without any ecological depth. See Huntsman, *The Maritime Salmon of Canada*, pp. 1-99; and "The Cause of Periodic Scarcity in Atlantic Salmon", *Transactions of the Royal Society of Canada*, Ser. 3, 31 (1937), Section 5, pp. 17-27. He brought his theories to the attention of the population biologists themselves by also publishing "Causation of the Nine or Ten Year Salmon Cycle", in the first volume of the *Journal of Cycle Research* (1951-52), pp. 43-53. In these articles he gave close consideration to the population theories of Charles P. Elton, the founding director of the Bureau of Animal Populations at Oxford University.

variations they were encountering in the field were environmentally-induced and more or less superficial, or actually different races. This uncertainty finally entered fisheries biology in the 1930s; a new wave of thinking began to replace the vogue of fish racial studies pioneered by Heincke, as some scientists became "more and more doubtful about the validity and importance of racial characteristics".[62] Frederick M. Davis of the Fisheries Laboratory in Lowestoft, wrote in 1935 of the two schools of thought concerning the "race question": "One school consider that there are 'races' that can be distinguished by hereditary characters. The other considers that the distinguishing characters are the result of environmental factors". Thus Davis considered that populations sharing similar physical and physiological characters were due to environmental influences in the area in which they were spawned: "One may consider the community as a real and constant entity. The term 'race' is, however, inapplicable owing to the postulate that racial characters, including the time and place of spawning, are hereditary".[63] This neatly encapsulates Huntsman's view.

Huntsman faced down some of his scientific adversaries on the race question at the "Conference on Salmon Problems" held on 30 June 1938 under the auspices of the Fisheries Research Board of Canada. Most of the discussion between papers was taken up by debate between Menzies and Huntsman about homing and migration, which rehashed the arguments that have already been presented. Both were battling with a collection of "facts" and no clear proof; Huntsman denied the reliability of circumstantial evidence while Menzies remained confident that direct proof for salmon migrations and homing was not necessary. Thus, most of the time they were at cross purposes with one another. However, on the question of salmon races, Huntsman secured at least a temporary victory. His position was reinforced by his own experiments with transplanted fry on Nova Scotia's Apple River and by work being done by C. McC. Mottley at the Pacific Biological Station concerning the number of vertebrae in the trout, *Salmo gairdneri Kamloops*. The number of vertebrae was one character used in systematics to identify species and varieties of fish. Economic fisheries biologists also employed vertebral counts to identify populations. Two schools of thought disagreed as to whether the number of vertebrae was determined by heredity alone, or by heredity within fairly broad limits, with the environment influencing the final number present.[64] Mottley's vertebral counts of the four species of *Salmo* found in British Columbia revealed that the number of vertebrae was "extremely variable". He found a significant

62 E.M. Thomasson, introduction to "A Contribution to the Race Question", in Thomasson, ed., *Study of the Sea* (Farnham, 1981), p. 124.

63 F.M. Davis, "A Contribution to the Race Question", in Thomasson, ed., *Study of the Sea*, pp. 124, 120.

64 C.McC. Mottley, "The Number of Vertebrae in Trout *(Salmo)*", *Journal of the Biological Board of Canada*, 3 (1937), p. 169.

difference between hatchery-reared *gairdnerii* and those from the natural environment, and fish from different year-groups all raised in the same hatchery. More significantly, from Huntsman's perspective, "fish reared in the hatchery had vertebral counts significantly different from their own parents, and broods reared in parallel under similar hatchery conditions were also different". Mottley warned: "The fact that the number of vertebrae in trout is capable of modification by changing the environmental conditions during development suggests caution in the use of it as a character for identifying populations of trout".[65] Due to their close phylogenetic relationship, Huntsman could easily extrapolate this finding from trout to Atlantic salmon. Huntsman managed to get the other biologists present at the "Conference on Salmon Problems" to agree that there must be some term to indicate these "stocks" without implying heredity. The term stock was finally chosen, as even Menzies finally admitted that there was no evidence of hereditary factors in the different river stocks.[66]

The failure of other scientists to understand Huntsman's arguments is exemplified by a contribution to this controversy published in March 1939 by Knut Dahl, the grand old man of Atlantic salmon research. He was impatient about Huntsman's persistence in questioning races and homing in salmon, especially since "Mr. Calderwood's urbane and mildly worded remonstrance has left [Huntsman] quite untouched". Dahl argued that circumstantial evidence, backed up by mathematical evidence, might "lead to a judgement as near to the truth as the human brain can come". The circumstantial evidence for homing and separate river races was derived "from a fact which ages ago has been patent to all observers of salmon rivers: that the salmon of different rivers are very different".[67] However, such an argument could hardly convince Huntsman, who had already proved to his own satisfaction that no hereditary factors were necessary to explain this phenomenon. Dahl knew this, and said that his use of the "term" races did not necessarily imply heredity. He merely meant that the differences between salmon stocks on different rivers would not remain constant if salmon did not return to their home river.

Dahl and his sympathizers were engaged in a classic circular argument, while Huntsman stood cynically outside of the circle. The interpretations which each brought to the same available data were radically different, and, again, conditioned by prior scientific or observational commitments. Dahl and Menzies had started from the perspective of a long history of observations by fishermen, and their

65 *Ibid.*, p.176.

66 "Conference on Salmon Problems", *American Association for the Advancement of Science*, Publication No. 8 (1939), p. 88.

67 Knut Dahl, "Homing Instinct in Salmon. The Case for Separate River Races", *Salmon and Trout Magazine*, 96 (September 1939), pp. 19, 20.

commitment could be termed "extra-scientific" in that these observations were patently untested. Huntsman, on the other hand, was bringing not only an environmentalist perspective, but experimental testing of his own and their assumptions. Their disagreement was not analogous to a Kuhnian paradigm-shift, because while Dahl and Menzies were unable to comprehend Huntsman's arguments, he fully understood theirs. Dahl had failed to grasp Huntsman's reasoning on two points. First, he did not comprehend Huntsman's argument that the environment could account for local variations in salmon, making unnecessary hereditary integrity preserved through the isolating mechanism of homing. For Huntsman, a stream or river's characteristics, such as temperature and food supply, would determine things like a salmon's growth rate and hence the length of time spent in the river. This could later affect the amount of time the salmon would need to spend in the sea, and salmon from a common source could also be argued to encounter common environmental conditions peculiar to the regions of the sea in which they would remain (since, according to Huntsman, they did not undergo long-distance migrations). Their behavioural response to these conditions would affect their appearance and also the periodicity of their descent to and return from the sea, regardless of the genetic stock from which such salmon spawned. The transplanted fry in the Apple river experiment seemed to reinforce this argument. Second, Huntsman did not deny that most salmon returned to spawn in the river in which they were hatched. Even Dahl's much better argument — that some rivers became depleted by overfishing while others did not, because homing insured that fish from well-stocked rivers would not stray to depleted rivers to spawn and thus replenish them — did not answer Huntsman's argument. Huntsman responded in a September 1939 article that most depleted rivers remained in that state because salmon from well-stocked rivers spent most of their time in the sea around the vicinity of the river's influence, so that it was unlikely they would stock other rivers by straying. He also objected to Dahl's use of the word "race" in a fashion that left out the concept of heredity, "which is the original meaning, and not easily kept out of mind".[68]

In this paper Huntsman also complained that Dahl had failed like everyone before him to provide a single clear case of a salmon returning from a distant place in the sea to its natal river. Huntsman had concluded from the study of three districts in Canadian waters that the feeding areas were just off the coasts along which salmon were taken with stationary or drift nets. In these areas, the salmon taken had been feeding, unlike the European fish netted in similar areas, which suggested that there was a lot more to be learned about salmon feeding behaviour.[69] Huntsman was unwilling to give way until someone could demonstrate

68 A.G. Huntsman, "Races and Homing Instinct, A Further Paper", *Salmon and Trout Magazine*, 96 (September 1939), p. 234.

69 *Ibid.*, p. 236.

a single, clear, documented case of a salmon returning to its home river from a distant place. Then, in 1940, came the crowning irony of Huntsman's career. Of 31,359 Atlantic salmon smolts marked by Huntsman and his associates on the Margaree River in 1938, one was taken at Bonavista on the East Coast of Newfoundland by Dr. A.A. Blair of the Newfoundland Fisheries Research Institute. He tagged it and released it on 17 June 1940, and it was taken again, on 21 September 1940, by an angler on the North-East Margaree River above its original place of marking. Thus Huntsman got the evidence he was demanding through his own researches. He was rather slow in reporting it: he finally announced his finding in the 10 April 1942 issue of *Science.*

At some point Huntsman's position had hardened from mere scepticism to become something stronger; the evidence indicates that his disbelief in salmon migration and homing was as firm as his opponents' belief. In his announcement of the return of this marked salmon from a distant place, he emphasised that the bulk of marked fish which were recaptured in 1940 and 1941 had been taken along the 16 mile stretch of coast north of the river mouth, which was the definite zone of influence of the Margaree River. Huntsman was sticking to his guns: "The facts for our salmon do not harmonize with the conception of a somewhat precise migration to a distant feeding ground....they give no indication as to the degree of success in return from distant places. Much more work needs to be done".[70] Although Huntsman's output of papers dealing exclusively with the homing instinct in salmon abated sharply thereafter, he continued to mark salmon for homing experiments, shifting his base from the Margaree to the Moser River in Nova Scotia in 1942. His views on the homing of salmon altered, partially as a result of his newer findings. An extremely important one was that marked Moser River salmon entered or even ascended other neighbouring rivers that drained country similar to that drained by the Moser River. However, although found in the region of the St. Mary River, they were never found in its strong outflow. The St. Mary River had the best salmon fishing in the district, but it drained "a large inland area that is geologically very different from the coastal country drained by other rivers in the district". Huntsman concluded that wandering salmon tended to enter and remain in water like that in which they had spent their river lives as parr. The quality of water somehow affected the salmon's actions: "In spite of the differences between the branches of a river, and in spite of the mixture of many different waters in the sea, the salmon is most apt to find in the outflow in the sea of its home river waters like that of the branch in which it lived as a parr. To reach that outflow, it may wander quite a long time".[71]

70 A.G. Huntsman, "Return of a Marked Salmon from a Distant Place", *Science*, 95 (1942), p. 382.

71 A.G. Huntsman, "Factors Which May Affect Migration: Some Examples from Canadian Fish", *Salmon and Trout Magazine*, 130 (September 1950), p. 238.

What is intriguing here is that Huntsman's finding that Moser River salmon would only enter rivers draining similar terrains dated from 1944.[72] His conclusion that perhaps the sense of smell played a role in this behaviour considerably presaged the olfactory hypothesis for salmon homing. This hypothesis was announced in 1951 by A.D. Hasler and his doctoral student, Warren Wisby.[73]

While Huntsman now accepted homing, he did not accept the idea of a "homing mechanism". For him, rather, a "wandering mechanism" would equally explain the phenomenon, without giving the salmon the appearance of purpose. Huntsman remained convinced that long-distance travels were the exception, and local wanderings the rule, because of the small percentage of returns from distant places in marking experiments. In Huntsman's new theory, "recognition of home water does not direct the fish home, but may stop the wandering".[74] In 1950 Huntsman clearly stated his changed position: "Homing is a very definite feature in salmon migration, but it is the end of wandering rather than a directive factor. In the sea, the shore and coast...transportation by currents are the definitely directive factors for salmon management".[75] While Huntsman came closer to (but never agreed with) the mainstream of thought on homing, he always was to maintain that only rarely did salmon travel long distances to their home streams; the majority did not stray far.

Few fisheries biologists had shared Huntsman's views and concerns. His refusal to accept Atlantic salmon migrations to feeding grounds off Greenland, in spite of increasing evidence, made other biologists unwilling to listen to his ideas. He had one last chance to air his views, at a symposium on Atlantic salmon in the autumn of 1972, which was sponsored by the Huntsman Marine Laboratory in St. Andrews, New Brunswick. He was not invited to give a talk, since everyone knew what he was going to say anyway, but still he insisted upon being on the program. Because he was by then a famous old scientist, Huntsman and his opinions stole the headlines, much to the consternation of the more conventional scientists whom he was discrediting.[76] By this time, Huntsman's views

72 See A.G. Huntsman, "Report for 1945 on the Atlantic Salmon and Trout Investigations", *Annual Report of the Fisheries Research Board of Canada for 1945* (Ottawa, 1946), p. 33.

73 Hasler and Wisby, *Olfactory Imprinting and Homing in Salmon*, p. 13. The olfactory hypothesis, which has held up well to subsequent tests, states that juvenile salmon become imprinted to the distinctive odour their home streams acquire from the local differences in soil and vegetation of the drainage basins. This olfactory imprinting is used by salmon to identify their home streams when returning to spawn.

74 A.G. Huntsman, "Wandering Versus Homing in Salmon", *Salmon and Trout Magazine*, 136 (September 1952), p. 188.

75 Huntsman, "Factors Which May Affect Migration", p. 239.

76 See Johnstone, *The Aquatic Explorers*, pp. 304-5.

were largely considered those of a crank by younger scientists. But was such a judgement warranted?

Huntsman had obviously taken a losing position on the questions of homing and migrations, and his stand on the problem of salmon races was only slightly more successful. However, this was not necessarily a reflection of his scientific ability or insights. For example, his earliest studies had concerned the salmon of the Saint John River, with its great estuary, and this work obviously subsequently coloured his outlook. Well after his death there came a confirmation that, in fact, not all salmon do embark on long-distance migrations. An article appearing in *Atlantic Salmon: Its Future* in 1980 reported:

> It appears from tagging experiments that not all mainland North American Atlantic stocks contribute to the distant fisheries in Newfoundland and Greenland. Salmon from the Penobscot, Machias and Naraguagas Rivers in Maine, and from Quebec and Northern New Brunswick contribute heavily to these distant fisheries, while stocks from the Bay of Fundy contribute to a lesser extent or not at all. Salmon from one of the Bay of Fundy stocks, the Big Salmon River, are rarely, if ever, taken outside of the Bay of Fundy.[77]

Huntsman, then, was making a valid point; some of the salmon he was studying did indeed behave as he claimed. As subsequent experience has shown, Huntsman's Bay of Fundy salmon do not represent the same situation as the salmon of Scotland and Norway. Nor was the importance Huntsman placed on hydrographic movements entirely erroneous. The study of salmon movements in relation to currents has recently engaged the attention of biologists studying the movements of Pacific salmon; more significance is being accorded to the role of currents in determining salmon movements.[78] Both Huntsman and the "salmon migrationists" — Dahl and Menzies — brought to the same salmon tagging data very different experiential backgrounds. In the case of Menzies and Dahl, faith in long-held fishermen's beliefs that salmon go elsewhere proved very fruitful, even if they

77 R.L.Saunders and J.L. Bailey, "The role of genetics in Atlantic salmon management", in A.E.J. Went, ed., *Atlantic Salmon: Its Future* (Farnham, 1980), p. 189.

78 M.C. Healey, "Juvenile Pacific Salmon in the Coastal Ecotone", paper given at the Canadian Conference for Fisheries Research, Ottawa, 5-6 January 1988. In the accompanying abstract, Healey wrote about the aims of the project (The Marine Survival of Salmon Program) in which he was participating, one of which was "to measure the dispersal and survival of Alberni Inlet sockeye during their migration northward along the west coast of Vancouver Island in relation to the stability and integrity of the Vancouver Island coastal current and water exchange processes that may affect local food supplies". "Abstracts: Canadian Conference for Fisheries Research. Ottawa, Ontario. January 5-6, 1988", p. 2.

were following the dubious practice of trying to prove rather than disprove a scientific hypothesis. Intuition and faith, in addition to his scientific procedures, aided Menzies. On the other hand, Huntsman approached the problem of migration filled with a healthy scientific scepticism, but also already armed with biases against purposive behaviour in salmon and in favour of the role of hydrographic currents. Neither the "winning" nor the "losing" side of the migration problem could be said to have been free from an "extra-scientific" agenda. The fact that Huntsman's theories were not entirely invalid also proves the significance of pursuing local scientific investigations, and the folly of always trying to impose a universal scientific theory — especially in biology, where local deviations, such as the case of non-migrating Bay of Fundy salmon, are too important to be ignored, if only for economic considerations.

On the question of homing, it appears that Huntsman's opponents had supported the right argument for the wrong reasons. Recent research indicates that 95 per cent of salmon home accurately to streams with more stable sources, while as many as 27 per cent of salmon from unstable coastal streams may stray.[79] However, Huntsman's early refutation of homing was subtle — simply, salmon did not properly home because they never left the river's influence in the first place. Huntsman became so attached to his denial of this phenomenon that he blinded himself to his own logical inconsistencies. For example, in the Apple River experiment, the East Apple had been chosen for transplanting salmon fry because it had no indigenous salmon due to a former obstructing dam, which had wiped out the river's salmon. However, the West Apple, which shared the same estuary, did have a run of salmon. Even if they never left the "zone of influence" of the Apple Rivers, half of these salmon should have randomly run up the West Apple and repopulated it, if no form of homing occurred. In both Huntsman's and his opponents cases, the non-scientific factor affecting their theory-making could be termed "common-sense reasoning", and their theories what Augustine Brannigan calls "folk theories".[80] Dahl and Menzies argued that homing had to occur because salmon races existed. They had no scientific evidence to back up their argument, and did not subject their theory to any tests, because the theory had a rational appeal. Huntsman, on the other hand, reasoned that salmon could not possibly possess the "intelligence" to be able to home, and so therefore they must not. Also if homing did occur, why do some salmon get "lost" ? The introduction of more sophisticated biochemistry to fisheries biology and the development of an understanding of imprinting by ethologists

79 T.P. Quinn, C.C. Wood, L. Margolis, B.E. Riddell and K.D. Hyatt, "Homing in Wild Sockeye Salmon (*Onchorynchus nerka*) Populations as Inferred from Differences in Parasite Prevalence and Allozyme Allele Frequencies", *Canadian Journal of Fisheries and Aquatic Sciences*, 44 (1987), p. 1970.

80 Augustine Brannigan, *The Social Basis of Scientific Construction* (New York, 1981), p. 145.

provided a means for producing the olfactory hypothesis for salmon homing, which successfully explained how and why salmon could and did home. Huntsman was not entirely inflexible, and retrenched his position, accepting the olfactory hypothesis to explain homing within the river. Huntsman's proposal of the alternative "wandering mechanism" was not a refutation of this kind of homing, but still an argument against directed long-distance migrations in the sea from and back to the home river. Indeed, the "wandering mechanism" might provide a good description of Bay of Fundy salmon behaviour.

Biologists trying to prove the existence of salmon races or to use these races as a means for understanding other problems are still dealing with an enigma. It is very difficult to tell where heredity stops and the environment takes over. Many fisheries biologists are proceeding as if such races exist, differentiating genetically-determined enzymes which vary in salmon from one stream to the next, as a means of backing up other identification methods, such as the use of local salmon parasites, in studies which depend upon being able to identify the geographical sources of salmon stocks. The "stock" concept, the cornerstone in the management of commercial and sport fisheries, is based on the importance of recognizing distinct breeding populations from which a congregation of individuals in a species may be derived.

> If individual stock size or recruitment is misestimated and a fishery continues harvesting at high levels, the more vulnerable (less productive) stocks may be seriously depleted or eliminated. Hence, in order to achieve optimal management of available resources, individual stocks must be treated as discrete management units.[81]

Because different stocks have different geographic origins, heavy use is made of geographic variations in traits. However, some researchers have recently pointed out that not only are these variations subtle, "making their identification and enumeration difficult", but they may also vary over time, a variation that tends to be neglected. By enumerating the meristic traits — the number of vertebrae, gill rakers, pectoral fin rays, and so on — these researchers only achieved 21 per cent correct classification, due to the large variations in these traits over time relative to geographic variations. They also found similar variations in characteristic enzymes and other traits measured by biochemical analysis, and caution that "it is clearly necessary that heritability estimates of the traits be made and that environmental influences be investigated by detailed sampling of both pheno-

81 D.M. Blouw and S.D. Saxon, "Temporal Variation of Meristic Traits within Atlantic Salmon (*Salmo salar*) Stock, and Implications for Stock Identification", *Canadian Journal of Fisheries and Aquatic Sciences*, 45 (1988), p. 1330.

types and environments through development, or by controlled experiments".[82]

The issue of "nature versus nurture" is very much alive in fisheries biology. In salmon studies, such things as the environmental and genetic components that influence sea age at maturity are being evaluated and the relative importance of these factors in influencing homing is still being questioned. As recently as 1987 some Pacific salmon researchers wrote: "Additional quantitative estimates of homing, particularly in wild populations in different types of river systems, will be needed to evaluate the relative importance of genetic and environmental factors influencing homing".[83] Given the unreliability of methods used to distinguish between stocks, this evaluation will be extremely tricky, and makes questionable the fisheries management practices which have long been based on the assumption that different fish stocks can be more or less easily distinguished, which is precisely the concern that Huntsman felt. On the race question, Huntsman was raising valuable objections to the assumptions which guided his scientific opponents. His task was made all the harder in the world of pre-Second World War biology by the facts that social racial assumptions were widespread, and racism even acceptable. These probably conditioned many biologists to extend racial assumptions and hereditarian theories to biological populations in their own fields of work, fields which did not necessarily provide them with the expertise or qualifications to understand the problems underlying racial theories in terms of genetics. Certainly this appears to have been true of Dahl and Calderwood. Another problem for Huntsman may have been the sheer glamour of genetics. It was once suggested that "Biologists, because of the very impressive advances in the science of genetics, are quite justifiably inclined to stress the importance of heredity in the human field".[84] By extension, this would be even easier in other areas of biological explanation. By contrast, ecology and environmentalism lacked the rigorous appeal of genetics, and seemed to have predictive abilities analogous to weather forecasts. Hence, Huntsman had also to fight the image of genetics and its perceived explanatory powers in proposing his own environmentalist interpretation for the differences between salmon stocks. Here again, then, extra-scientific factors influenced the theories held by Huntsman's opponents, if not by Huntsman himself, and helped to heat up the debate. It is noteworthy that the issue of salmon races seems to have died at some point during World War II; correspondence between Huntsman and Menzies indicates that Menzies was eventually completely con-

82 *Ibid.*, pp. 1331, 1336, 1337.

83 Quinn, Wood, Margolis, Riddell and Hyatt, "Homing in Wild Sockeye Salmon", p. 1970; and see E. Michael P. Chadwick, Ross R. Clayton and Claude E. Léger, "Inverse Correlation between Ovarian Development of Atlantic Salmon (*Salmo salar*) Smolts and Sea Age", *Canadian Journal of Fisheries and Aquatic Sciences*, 44 (1987), pp. 1320-5.

84 See William Pastore, *The Nature-Nurture Controversy* (New York, 1949), p. 178.

vinced by Huntsman's arguments,[85] while Calderwood, who had completed his career, and Dahl, who was nearing retirement, were perhaps tired of the whole issue. While the case for salmon homing was won by Hasler and Wisby's olfactory hypothesis within 15 years of Huntsman's first public denial of salmon homing, the problem of salmon races over which Huntsman and his contemporaries had struggled was not resolved. The paths followed by this continuing debate are beyond the scope of this paper, but should any person wish to explore them, it is certain that the sources of the debate will partially lie in "extra-scientific" factors, probably extraordinarily more complex than those revealed here for the debate in the 1930s and 1940s.

85 See Huntsman Collection, Accession B78-0010/0010, File 8, in the University of Toronto Archives.