The development in Germany of the one-stage process for destructive hydrogenation of crude oil to gasoline with new catalysts occupied most of the discussion as regards hydrogenation. Combined hydrogenation and catalytic or thermal cracking processes are likely to be used on a large scale in Germany.

In the session on catalytic reforming, an interesting paper was that by E. V. Murphree on a fluid hydroforming process, which is claimed to produce gasoline of improved octane rating. The fluid-process plant was said to cost 40 per cent less than fixed-bed units.

A paper on a new process for the polymerization of gaseous olefins to motor gasoline gave rise to interesting comparisons with the well-established solid phosphoric acid process.

The importance of sulphur removal and recovery from petroleum products was reflected in the five papers in the session on chemical treating processes. Methods for sulphur removal ranged from conventional soda sweetening of gasoline to hydrofining —selective hydrogenation of sulphur compounds. The latter process has attractive prospects.

Petroleum Chemicals. This section was concerned with the properties and the application of petroleum-based chemicals. Thus, in the detergent session, the five papers related to the extraordinary growth of petroleum detergents in the United States, where such materials now account for 55 per cent of the total American production of synthetic detergents. It was clear that the market outside the United States cannot be forecast from American developments, and it appeared that although the alkyl aryl sulphonates lead in the detergent field, alkyl sulphates, when prepared from petroleum, are likely to challenge their position. The influence on detergent properties of the hydrocarbon constitution was specially discussed.

In regard to biocides, it was stated that our knowledge of the chemical and physical compositions of mineral oils is still insufficient to guarantee that a certain oil would be suitable for agricultural use without previous field testing.

Composition of Petroleum. During the discussion of a group of papers on pure hydrocarbons, attention was directed to the fact that international exchange of data on these materials could be improved. It was therefore recommended that the extension of such exchange of research data should be explored. The discussion dealt mainly with the suitability of different criteria for determining hydrocarbon purity, and with the applicability of various physical constants for identifying and analysing hydrocarbons.

Properties of crude oils were considered from two aspects: first, the classification and evaluation of crude oils; and secondly, their commercial evaluation. It was considered that characterizing factors now used do not correlate with chemical composition but mainly summarize the physical properties. It would be convenient, although it did not appear possible, to combine the two aspects into one simple factor. It was concluded that knowledge of the chemical composition of crude oils necessitates a more complicated scheme of analysis, which would require more uniformity in methods of investigation in order to correlate results obtained all over the world.

Ten papers in this section were devoted to various aspects of the constitution of petroleum. The investigation of the complex mixtures of which petroleum fractions are composed has been simplified by modern methods of group analyses. In regard to determination of oil composition by spectrographic analysis, it was considered that the emphasis should be more on so-called type analyses.

Utilization. Papers in this section dealt with the utilization of such petroleum products as engine fuels, lubricants, heating fuels and bitumen.

In the session on gasoline engine fuels, the reduction of engine friction was suggested as an alternative to higher compression ratios in order to reduce fuel consumption. It was also pointed out that there is room for improvement in automatic control of spark advance. In the overall economic picture, increased cost of high-compression engines should be weighed against increased cost of producing higher anti-knock gasoline.

The gas turbine fuel session discussed three aspects of the general subject. First to be considered was the complicated position which exists because the severe cold-test requirement of aircraft turbine fuel specifications limits the supply sources. Opinions varied widely as to the extent to which engine and fuel should contribute to the solution of the problem. Secondly, on the use of boiler-type fuels in stationary and marine gas turbines, the economics are not favourable without a cheap fuel. Difficulties due to varying percentages and composition of ash from the fuel are still serious. Finally, the Pescara system as applied to locomotives was dealt with. In this system a free-piston diesel is combined with a turbine, through which it develops its power and which functions simultaneously as a variable-torque transmission element.

Four papers on motor lubricants all dealt with some aspect of additives; the general comment was that the large amount of research being carried out is insufficiently stressed. It was also suggested that viscosity-index improvers may not be effective at high rates of shear, the effect of pressure not having been investigated. Industrial and special lubricants and electrical oils were also discussed.

Construction Materials. This section dealt mainly with materials, construction, equipment and corrosion. One interesting proposal made by two French authors is for a method of heat exchange whereby the two fluids are in direct contact. It was stated that it is effective where there is no danger of emulsions being formed due to the nature of the oil or of the cooling water.

Miscellaneous. Sections 9 and 10 dealt respectively with transport, storage and distribution of petroleum products, and with economics, statistics, documentation, education and training.

HUMAN PROBLEMS OF THE SCOTTISH HIGHLANDS

IN an article in a recent issue of the *American Scientist* (39, No. 2; April 1951), Dr. Fraser Darling discusses recent concepts of human ecology. Human ecology, he suggests, deals with the structure of animal communities which man dominates and their development through the ecological principles of succession. With Paul Sears he believes that "the social function of ecology is to provide a scientific basis whereby man may shape the environment and his relations to it as he expresses himself in and through his culture patterns". To-day it would not

be wise to set up human ecology as an exact science but rather to say that human problems may be nearer solution if they are tackled ecologically. Human ecology and social science can be good science but should not be confused with social service, as is so often done.

Dr. Fraser Darling also considers whether there is any difference between human ecology and social anthropology. If there is any difference between them, he suggests, it is that human ecology deals essentially with process, and the value of the ecologist in society will be in his power and accuracy in elucidating causes and forecasting consequences.

The West Highlands of Scotland, for example, may serve to illustrate the ecological approach to the study of behaviour. In the Highlands there is a very old and, in many ways, primitive human culture existing in an administratively awkward and physically refractory terrain set on the fringe of a highly industrialized urban civilization. Highlanders have been part and parcel of the national structure of Britain for only two hundred years, having until then lived a different kind of life in standards, laws, language and techniques from the rest of Britain. Yet Highlanders are not New Hebrideans or Eskimos over whom British people, try as they may to the contrary, feel some kind of mental superiority. The Highlanders are a race of people of probably greater average intelligence and intellect than the rest of the British community though indistinguishable from it in physical appearance. As members of this race moved so smoothly and successfully in the 'dominant' civilization, it was overlooked how different was the inner rhythm of life and the style of thought and tradition. The new centralized British government of that day merely extended its administrative, economic and social regime to include the Highlands, and with some ameliorations and some encrustations this applies to-day.

In human ecology, too, history can never be neglected; a cross-sectional social survey is not ecological unless it studies origins and successions or, in other words, process. The significance of political action as an environmental factor must also be remembered. The manipulation of the salt tax, for example, in the last part of the eighteenth and early nineteenth centuries had profound results on the lives of Highlanders, and the transposition of the English system of poor relief had amazing consequences. Again, the island of Islay was immune from spirit duty in the late eighteenth century, distillers flocked in, the bread corn of the people was deflected to whisky, the distillers were soon making money advances (at their own rates) on the barley crops of small tenants, and drunkenness was rife and the people were reduced to an appalling social state. The detailed research into population movement conducted by the West Highland Survey shows that this island has suffered more than any other part of the Highlands from excessive emigration.

Another historical factor at the root of the Highland problem to-day is the exploitation which natural resources suffered in the past. Among these was the cutting down of forests to supply wood for shipbuilding and iron making. The destruction of the forests meant the removal of cover, and this environmental factor is of great importance in human lives. Lack of cover imposes various social problems in certain kinds of urban communities, and in the Highlands has imposed a set of conventions almost the exact opposite of our own. Darkness is the only cover; but this is supplemented by a build-up of psychological cover. The Tiree crofter visits the Duke of Argyll's factor on the nights of no moon, though he could just as well go in the day. A man and a girl in the Hebrides will ignore each other in daytime should they meet on the road; but he will be calling at her home just about the time of night when in our culture we should have taken our leave. Good manners require that he be gone before it is light.

The ultimate disappearance of the forest was followed by the introduction of sheep farming on the extensive extractive system in the second half of the eighteenth century. The immediate social consequences of this were unfortunate in that the people were pushed to the coast and suffered a forcible social break. In other parts the sheep–cattle ratio is grossly disturbed and conditions for the peasantry become desperate. In the Highlands it is now possible to gauge the social health of the people by knowledge of the sheep–cattle ratio in an area. If the ratio is wide, 30–50 or more sheep to one cattle-beast, there are grave social problems; if it is less than ten, there are few. The sheep–cattle ratio can also be correlated with the age-structure of the population. It is children who keep milk-cows on the land and when the population grows old, as it did in Assynt in 1931, the number of milk-cows goes down.

Nor should the human ecologist forget the diet of the people he is studying. The introduction of the potato in the West Highlands has raised many social problems caused by an increase in the population and a fall in the standard of living.

The attempt to study social and economic problems apart from the ecological background is bound to cause difficulties. Yet, contrary to biological principles, politicians have recently decided to give a substantial subsidy to hill ewes in Scotland. This idea may have worked well in the Southern Uplands of Scotland but in the poor terrain of the Highlands might have been specially designed for further deterioration of the habitat and for fostering social unhealth.

Depopulation and deterioration of the age-structure go together, but they bring a new set of social problems. People in and out of the Highlands have said often that industries should be established there, industries of the kind where wheels go round in an important way. But what has happened? Where such industry has been established, there has been even greater depopulation in the adjacent rural areas; yet the big problem is how to maintain dispersion. Fort William and Kinlockleven may have provided Britain with aluminium; but they have created new social problems and solved none.

In small communities problems of human ecology arising from depopulation and deterioration of the age-structure are manifold. In the first place, the old remain in power and so prevail that they can initiate an era of reaction in the life of a community; so that in a region of strict Presbyterianism, all gaiety for the young is frowned upon and nowhere do the young show greater consideration for the old than in the Highlands. There are many townships where there are but few married couples. Brothers and sisters have cared for their old folk, and now that they are gone they continue living in their parents' houses and cannot bring themselves to the considerable upset of getting married. The social urge and necessary gaiety are not there. This depres-

sion of the vivid social life of man is likely to lead to such undesirable consequences as burning of the hills in an excitement bordering on hysteria.

Religion is also a considerable ecological factor; but it must always be related with other environmental characteristics. In the Highlands a small remote community with poor services might have much more chance of survival if it were Catholic than if it were free Presbyterian; there is a greater sense of freedom in the old liberal and almost Columban style of Catholicism. Dr. Darling also suggests that, despite the fact that tradition and accumulated experience are part of man's environment, and for all the importance of the physical and biological factors, the ethos is still the biggest ecological factor of all in the life of the individual.

MECHANISM OF RESISTANCE TO INSECTICIDE IN HOUSEFLIES

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LABORATORY tests have revealed interesting differences in the type of tolerance of two strains of insecticide-resistant housefly. The strains investigated were:

Italian Resistant Strain. Following one of the earliest observations[1] of DDT-resistant houseflies, a laboratory colony was started at the Istituto Superiore di Sanita in Rome. A sub-colony was kindly sent to us in 1948 and has been cultured at the London School of Hygiene and Tropical Medicine since, with occasional selection for resistance to DDT[2], but no other insecticide.

Sardinian Resistant Strain. During 1947–50 there was widespread house-spraying with residual insecticides in Sardinia, in connexion with a campaign for the eradication of Anophelines[3]. Flies were observed to have become resistant to 'Chlordane' and gamma benzene hexachloride, as well as to DDT. In October 1950 Mr. J. F. Newman brought to England a colony of these flies and kindly let me have a sub-culture.

Normal (Rome) Flies. A colony started from normally susceptible flies in Rome before wide use of DDT, sent to us in 1948 and maintained here since.

The flies were reared and tested in rooms kept at 27° C. Two methods were used to assess resistance:

(1) *Application Test.* Minute drops (0·4 mm.^{3}) of insecticides dissolved in mineral oil were applied to individual flies, narcotized with carbon dioxide, by an 'Agla' micro-injection apparatus. Median lethal concentrations were estimated graphically from probit/log concentration curves based on 24-hr. kills.

(2) *Knock-down Test.* Observations were made of the rate of knock-down of flies in a 500-ml. beaker treated with acetone solution of DDT to leave a residue of 0·01 mgm. per sq. cm.[4].

Resistance to DDT

Effect of solvent used. Mineral oil was used in application tests rather than acetone (which has been used by other investigators) because of the difficulty of dealing with minute drops of a highly volatile solvent. Some comparative tests with oil and acetone showed how greatly this small point of technique affects the degree of resistance recorded (Table 1).

Table 1

	Median lethal dose (micrograms per fly)		Ratio Sardinian/ normal
	Normal flies	Sardinian flies	
DDT in oil	0·44	7·2	16
DDT in acetone	0·12	36	300

The results obtained with acetone are in line with those of other investigators who have recorded resistance ratios of several hundred to one; but the oil solution results seem more reliable for the following reasons.

The thorax of a treated fly remains covered with a film of oil, forming a primary toxic phase which, by the partition law, saturates all phases (tissues) in the proportion of the original solution. Internal depletion by metabolism could be made good from this reservoir. Losses of the film, by contacts of the fly with the cage, should be equal at all doses, since the volume applied is constant. After application in acetone, the solvent evaporates in a few seconds, leaving supersaturated liquid; this crystallizes out in an hour or so, leaving tiny scales and blobs of DDT crystals at higher doses. As there is no oil film, the cuticle wax of the insect must form the primary phase. There is very little of this, so it is easily saturated, and this saturates other tissues with DDT; therefore, the toxic action on susceptible flies is greater than with oil applications. The resistant flies, however, are able to metabolize the DDT (see below) and deplete the small reservoir in the cuticle wax. The relatively large crystals aggregated on the outside are an inefficient means of maintaining the saturation of the wax, apart from the fact that they may be dislodged by the movements of the fly. This accounts for the higher doses needed to kill the resistant flies.

Speed of 'knock-down' by DDT. In tests in which DDT was applied to the thorax, flies of the Italian and Sardinian strains were about equally resistant to DDT; but in the beaker tests there was a very marked difference, as shown by the results in Table 2.

Table 2

	Normal Rome strain		Italian strain		Sardinian strain	
	Males	Females	Males	Females	Males	Females
Percentage down in 20 min.	86	35	7	0	69	27
Percentage down in 40 min.	100	93	24	11	93	80
Percentage dead after 24 hr.	100	100	19	8	30	11

The Sardinian flies are almost as rapidly paralysed by the DDT as the normal strain, but most of them recover if removed from the surface after 40 min. The Italian flies, as shown by Harrison[2], are highly resistant to the paralysing effect.

Toxicity of DDT after injection. The relative resistance of the three strains of fly to DDT (in oil) was very similar if the insecticide was injected into the thorax instead of being applied to the outside. The median lethal concentrations obtained were about half those in application tests, thus: Rome 0·06 per cent; Italian 1·0 per cent; Sardinian 0·9 per cent. The paralysing effect of DDT was exhibited earlier by the Sardinian flies than the Italian ones, after injection as well as after application of the poison, though the final kills were about the same.