edge and quite superficial for the purposes of practical plant and animal breeding. Nor does it satisfy the requirements of a thorough study of species from an evolutionary point of view. We are now entering an epoch of differential, ecological, physiological and genetic classification. It is an immense work. The ocean of knowledge is practically untouched by biologists. It requires the joint labors of many different specialists—physiologists, cytologists, geneticists, systematists and biochemists. It requires the international spirit, the cooperative work of investigators throughout the whole world.'')

DR. JULIAN HUXLEY, who edited the book, contributed a general introductory chapter, often critically summarizing the essential contents of subsequent chapters.

"The New Systematics" is the society's first large cooperative publication. It is not a manual that will help a young taxonomist anxious to start working along new lines with as simple indications as the morphologists and anatomists of one or two generations ago found in Strasburger or Chamberlain. It is much more a collection of discussions and essays which one will have to read, reread and compare to make the best use of. Most of us taxonomists, feeling as we all do that our methods resemble more those of the bibliographer than those of the accurate experimental scientist, will gladly make this effort and will be rewarded by discovering a volume as inspiring as Linné's "Philosophia" and De Candolle's "Phytographie." Yet it carries another message. Linné (eighteenth century) taught us new methods of investigation and description; De Candolle (nineteenth century), in addition to these, new methods of documentation. The message of this twentieth century book is that taxonomy is going to be a field of cooperative research. This is important news for all who take the future of American science to heart, for nowhere in the world at present are conditions so suitable for large-scale cooperative research as in the New World.

The book shows better than any similar recent publication how the old taxonomist, who preferred the company of plants to that of men—the interesting figure of a generation ago, whose love for the *scientia amabilis* resulted very often from a desire to escape human society, will have to make place for another type of scientist anxious to cooperate and to organize collaboration with and between workers in many branches of general biology.

Julian Huxley on his last visit to this country urged the foundation of a society similar to the British society. May this book in the States be a stimulus to bring American taxonomists and general biologists closer together.

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SPECIAL ARTICLES

A CANCEROGENIC TISSUE EXTRACT FROM HUMAN SOURCES[1]

AN extract has been prepared from the livers of persons who died of cancer which on subcutaneous injection into mice produced sarcomas at the site of injection.

In one experiment 9,420 grams of liver obtained from eight cases were extracted. These people had carcinoma of the stomach (three cases), carcinoma of the lung (two cases), carcinoma of the esophagus, pancreas, and rectum (one case of each). There were no carcinoma metastases visible in the livers grossly or microscopically.

The livers were ground and preserved in an equal volume of 95 per cent. alcohol. They were then saponified with alcoholic KOH for 24 hours in a steam bath, a volume of water equal to that of the alcohol in the mixture being added. The material was then extracted repeatedly with ethylene dichloride. This extract was evaporated to dryness at reduced pressure and the residue was resaponified. The final unsaponifiable residue so obtained was a flaky brown material with a disagreeable odor.

This residue was dissolved by warming with sesame oil. The oil has been tested repeatedly, unheated and after heating, and found not to be cancerogenic. About half a gram of extract dissolved in .5 cc of sesame oil was injected subcutaneously in 56 mice on June 1, 1939. The test of the potency of the extract was by no means quantitative because great but variable amounts were lost by sloughing at the site of injection. The mice used were of our own albino stock. They were of both sexes and were from 55 to 83 days old at the time of injection. Over two thousand mice of this stock have been used in a series of long-time experiments and a spontaneous spindle cell sarcoma has never been observed in them. The stock carries a small incidence of spontaneous mammary gland tumors, lymphatic diseases and lung tumors.

The first tumor appeared between five and six months after injection, and the mouse died on December 7, 1939, 182 days after injection. The tumor was large, measuring $33 \times 25 \times 22$ mm. It lay in the subcutaneous tissues and infiltrated the underlying muscle and overlying skin. It had not metastasized. Microscopically it was a spindle cell sarcoma, which resembled the sarcomas induced by the common carcinogens.

At this time 37 of the original 56 mice were living. Some of these quickly developed tumors, so that at

[1] This work was aided by a grant from the National Advisory Cancer Council.

the end of 16 months, 13 tumors have appeared, and 7 mice are still alive without visible tumors. The number and rate of death with tumors is shown in Table 1.

TABLE 1

Time in months	Living mice	Dead with tumors
0	56	0
5	45	0
6	42	0
7	37	1
8	34	4
9	32	6
10	21	7
11	20	8
12	15	10
13	13	12
14	10	12
15	8	13
16	7	13

These tumors are all spindle or polymorphous cell sarcomas. One has shown metastases to the lungs. They grew rapidly after they first appeared, killing the animals in about three weeks. Much of the injected extract was seen in the subcutaneous tissues. Although it was injected dorsally in the interscapular region part of it gradually migrated to the lateral and even ventral subcutaneous tissues. The sarcomas appeared to arise directly in this orange or brown material, and in two mice multiple, apparently independent, sarcomas were found surrounded by the extract.

Attempts at transplantation were made with three tumors from different mice. Although the recipients were not of a highly inbred stock and the number of animals used was small (five to six) transplantation was successful with two of the three tumors. Serial transplantation was then carried through the fourth transplant generation when it was permitted to die.

Control experiments of several kinds have been made:

Control A. Livers from seven persons who died of a variety of non-neoplastic diseases were extracted in exactly the same way. This nonsaponifiable residue has induced no tumors. The experiment was an exact duplicate of that just described except that the amount injected at one time was only half as large (about 250 mg), but a second injection of the same size was made sixty-five days afterward. Thus the total amount injected was approximately the same, namely 500 mg. The dose was divided in an attempt to reduce sloughing with loss of the extract. Sixty-three mice were originally injected, of which fifty-two are alive and without tumor 220 days after the first injection.

Control B. The non-saponifiable residue from 7,970 gm of carcinoma tissue has failed to induce tumors in experiments identical with those of the livers from cancer patients. In this experiment one injection of .5 gm of extract was made. Thirty-four mice are alive at the end of fourteen months and are without tumor.

Control C. The non-saponifiable residue from 18,435 gms of cancer tissue has failed to produce tumors in mice. These tissues had been fixed by the Kaiserling method before the saponification was made. The cholesterol was also removed from the residue before injections were made. In this experiment an initial injection of 250 mg of the non-saponifiable residue was made into each mouse on December 29, 1939, followed by injections of 100 mg on February 23, 1940, 100 mg on March 25, 1940, and 100 mg on April 22, 1940. Nine months after the first injection thirty mice are living without tumor. The total dose of 550 mg is relatively larger than that used in the other experiments because most of the cholesterol had been removed from this extract.

The results of the control experiments B and C are of interest in view of the experiments recently announced by Menke.[2] By the use of fat solvents he obtained extracts from human mammary gland carcinomas which have induced one tumor in each of two experiments.

Schabad reported the production of tumors by a benzene extract of a liver from a patient with primary carcinoma of the stomach.[3] Heiger has confirmed these results according to Cook,[4] and who gave no details.

A benzene extract of a liver from a case of carcinoma of the stomach has not yielded any tumors in our laboratory, although a total 2.5 cc of the extract was injected in five doses over a period of sixteen weeks. Twenty-six mice lived for six months after the first injection, twenty-one lived for eight months, and nineteen lived for nine months without developing tumors at the site of injection.

It appears then that the non-saponifiable residue of the livers of persons who had cancer, the livers not being involved, contain substances which are cancerogenic for mice. Although sufficient time has not lapsed to permit final conclusions, to date a similar extract from the livers of non-cancer bearing persons has not induced tumors. Similarly, by this method of preparation, cancer tissues themselves did not yield cancerogenic substances.

Experiments are in progress on the chemical separation, on the relation to the type of cancer, on the distribution within the body and on the origin of the substance.

NOTE: The author is indebted to Dr. Carl Marberg, who suggested the method of chemical procedure, and supervised the preliminary chemical work.

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[2] John F. Menke, SCIENCE, 92: 290, 1940.

[3] L. M. Schabad, *Compt. rend. Soc. de Biol.*, 124: 213, 1937.

[4] J. W. Cook, E. L. Kennaway and N. M. Kennaway, *Nature*, 145: 627, 1940.