although it does not provide effective control of other organisms which cause fouling of ship bottoms. It does not wash away in sea water over a four-month period, and it retains its effectiveness when incorporated as a constituent of paint. Admixture of DDT does not appear to have an adverse effect on the drying properties or durability of the paint. These experiments suggest that an ideal ship-bottom finish could combine the more general effectiveness of copper bottom paint with the relatively specific antibarnacle effect obtainable with an admixture of DDT.

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The Therapeutic Effect of Folic Acid in Tropical Sprue[1,2]

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The discovery that folic acid is an effective substance in the treatment of pernicious anemia and nutritional macrocytic anemia marks the culmination of an epoch in the study of these diseases. The present report demonstrates that folic acid benefits persons with tropical sprue.

Folic acid is a substance which is present in small amounts in liver, yeast, and other foods. The study of Spies and his associates (*1, 2*) showing that there is a remarkable response of improvement in the blood picture of persons with Addisonian pernicious anemia, nutritional macrocytic anemia, and the macrocytic anemia of pregnancy, of pellagra, and now of tropical sprue reveals the close relationship existing between the field of hematology and that of nutrition. These new discoveries promise to open a new era for the study of the pathogenesis of the various types of macrocytic anemia.

Macrocytic anemias occur throughout the world. Addisonian pernicious anemia occurs more in temperate zones and sprue in the tropics. The *British Medical Journal* (*3*) has recently stated that the British Empire is the world's largest reservoir of nutritional macrocytic anemia and sprue.

In order to cooperate in a study of sprue in the tropics the senior author accepted the invitation of Drs. Morales Otero and Ramon M. Suarez to form a cooperative study between the University of Cincinnati and the School of Tropical Medicine, San Juan, Puerto Rico. From a number of emaciated patients who had glossitis and diarrhea, and who passed light-colored, bulky, and frothy stools, we chose and hospitalized five patients. The criteria used in their selection were as follows: (1) The patient must have macrocytic anemia as determined by Wintrobe indices. (2) The bone marrow must show the typical erythroblastic arrest seen in macrocytic anemia. (3) The erythrocyte counts must be below 2,500,000. (4) The patient must be untreated, or he must not have been treated recently enough to interfere in any way with our evaluation of the effect of folic acid. (5) He must have persistently low reticulocyte counts during the period of observation. (6) He must have glossitis, and diarrhea characterized by fatty stools.

TABLE 1

ANTIANEMIC EFFECT OF FOLIC ACID IN TROPICAL SPRUE

	RBC (millions)		Hg. (grams)		Reticulocytes (%)			Dosage of Folic Acid			
Case No.	Initial day	Final day	Initial day	Final day	1st day of rise	Day of peak	% at peak	Daily dosage mg.	No. of days	Total mg.	Diet
1	.6	2.25	2.4	7.5	4	5	18	50	18	900	No meat products or yeast
2	1.0	2.02	4.9	6.9	5	6	25.4	50	14	700	
3	1.7	2.48	8.4	10.1	3	5	17.0	50	14	700	
4	2.3	2.5	10.1	11.0	3	4	7.8	50	12	600	
5	2.1	2.7	9.9	10.1	4	7	21.2	50	8	400	Meat allowed

Four of the patients were restricted to a diet devoid of meat, kidney, yeast, liver, and other meat products. Case 5 received some meat and meat products.

Following the oral administration of folic acid, the clinical improvement of the patients was so striking that all observers noticed on the third or fourth day an increase in the sense of well-being, strength, and

[1] University of Cincinnati Studies in Nutrition at San Juan, Puerto Rico, in cooperation with the School of Tropical Medicine, San Juan. Technical assistance was given by Clemencia Benitez Gautier, M. T. Expenses of the study were borne by grants from the Lederle Laboratories, Inc., which also supplied the folic acid, and the Edward Mason Williams Fund.

[2] Since the time this manuscript was submitted, Darby, Jones, and Johnson (*J. Amer. med. Ass.*, 1946, **130**, 780) and Moore, Bierbaum, Welch, and Wright (*J. lab. clin. Med.*, 1945, **30**, 1056) have shown the effect of synthetic *L. casei* factor on three cases and one case, respectively, of nontropical sprue. Spies, Lopez, Menendez, Minnich, and Koch (*S. med. J.*, 1946, **39**, 30–32) and Spies, Milanes, Menendez, Koch, and Minnich (*J. lab. clin. Med.*, 1946, **31**, 227–241) have shown the effect of synthetic *L. casei* factor on three and nine cases, respectively, of tropical sprue. In every instance the findings are similar to those reported in this paper.

vigor. The patients who had been unwilling to eat now ate everything on their trays and requested more. A part of the clinical improvement included a disappearance of the "indigestion," anorexia, sore tongue, pallor, and exhaustion, and a decrease in the amount of the stools. This occurred at about the time of the onset of remission. The remission itself was characterized by a reticulocytosis beginning on the third or fourth day and peaking around the sixth. As seen in Table 1, the reticulocytosis, in turn, was followed by an increase in the number of red blood cells and the hemoglobin. These patients showed a typical hematopoietic response following the administration of folic acid under conditions which make it certain that the folic acid produced the results.

Accordingly, we must state that these findings demonstrate clearly that folic acid produces beneficial effects in persons with tropical sprue in relapse. These and additional patients are being investigated to determine the long-time effects of folic acid on this disease. Some of them will receive a diet devoid of meat and meat products, and others will receive an antisprue diet.

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Food of Nymphs and Adults of *Neoschöngastia indica* (Hirst 1915)

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Medical research on tsutsugamushi fever or scrub typhus has been severely handicapped by the inability of investigators to culture mites of the family Trombiculidae. The disease is carried to men by the larvae of *Trombicula akamushi* and closely related species. The larval stage is the only parasitic instar of trombiculid mites. In order to culture these mites a satisfactory food must be provided for the nymphs and adults, which are free-living.

Ewing (*2*) discusses the attempts of previous workers to rear trombiculid mites. Engorged larvae have been reared to adults in a few cases but never in numbers and never consistently. Ewing (*1*) used feces of millipedes and springtails as food for nymphs and adults of *Eutrombicula alfreddugèsi*; Miyajima and Okumura (*3*) provided nymphs of *Trombicula akamushi* with pieces of melons and potatoes; while decomposing vegetable matter was used by Nagayo, *et al.* (*4*) for several species of *Trombicula*.

Nymphs and adults of *Neoschöngastia indica* were used in the present study on the food habits of trombiculid mites. The larvae of *N. indica* were common in the ears of a wild subspecies of *Rattus rattus* that was common on Guam in the jungles adjacent to the laboratories of U. S. Naval Medical Research Unit No. 2. The nymphs, adults, and unattached larvae were common in the nests and covered runways of the rats.

Live rats were supplied frequently by the Laboratory of Mammalogy. These were kept in cages for at least seven days prior to removal of the larvae of *N. indica* from their ears in order that a supply of engorged larvae might be assured. The larvae thus obtained were placed in culture bottles, which were wide-mouthed, low-form, glass-stoppered, weighing bottles of 25-cc. capacity, coated on the sides and bottom with a thick layer of plaster of Paris blackened by the addition of 5 per cent activated charcoal. These bottles were kept in an incubator in which a temperature of 32° C. was maintained. Five days after the engorged larvae were placed in the culture bottles, nymphs emerged. The bottles containing these nymphs and similar bottles to which nymphs and adults captured in the field had been added were used as cultures for testing the suitability of various foods for the free-living stages of *N. indica*. The usual number of nymphs or adults in a culture was about 30, but some contained only one while a few had as many as 100. Nymphs and adults remained active and apparently healthy in the culture bottles as long as the plaster was moist enough to produce droplets of condensed water on the inner side of the glass cover.

Pieces of potato, papaya, apple, and decaying wood; feces of springtails, millipedes, rats, and noddy terns; concentrates of soil containing nematodes, rotifers, protozoans, and various free-living mites; litter from the floor of the jungle; broth made from potatoes; dried serum; a nutrient solution containing amino acids, sugars, and vitamins; fungi; and live springtails and millipedes were tried singly or in various combinations as food for the cultures. One adult developed in one of 11 cultures of younger forms fed on concentrates of soil, and a second in one culture of 11 fed on litter from the jungle to which a live millipede had been added. The above results are similar to those achieved by previous workers.

Nymphs appeared to feed on many of the foods offered and even on the plaster itself. However, even

[1] On military leave from Duke University.
[2] The opinions expressed are not necessarily those of the Navy Department.