Where, then, are we to look for an improvement? Some would find a remedy in the imposition of heavy protective tariffs, but such tariffs in France have not availed to prevent a similar state of things there, and protection in coloring matters might have a very detrimental effect upon the textile industries of the country. Others expect salvation from the extension of technical schools, but laudable as is the aim of these institutions, I cannot see how they can effect much until their raw material is of a very different character from what it is at present, and until the public can be completely disabused of the fallacy that a year or two of technical training pumped into an ignorant schoolboy will produce a better works-chemist than a university course of scientific study laid upon the foundation of a good general education.

The remedy for the present state of affairs must of necessity be a slow one, and in my opinion can only be found in a better appreciation of the value of science throughout the length and breadth of the land. Until our government and public men can be brought to realize the importance of fostering the study of science, and of encouraging all scientific industries, until our schools and universities appreciate the importance of a scientific education, until the rewards for public service in science are made equal to those in other branches of public service, so long will science continue to be held in insufficient esteem in our country. It is not so much the education of our chemists which is at fault as the scientific education of the public as a whole.

When our capitalists more completely realize the importance of calling in the aid of the best scientific skill available, when our universities and technical schools are able to supply a sufficient number of highly educated chemists equal in knowledge, originality and resource to those trained in German universities, when our professors and manufacturers are willing to work together in this and other matters, when our patent laws are rendered just to ourselves, we may confidently hope that our natural engineering skill and practical resource will once more bring us to the front.

CONCERNING CERTAIN MOSQUITOES.

DURING the season of 1901 the writer studied the mosquito problem, as it exists in the State of New Jersey, with a view to determining whether it was possible in any way to reduce or control the number of these pests in the State. It was decided that the first point of importance was to ascertain just what species was or were the most troublesome, and just where these troublesome species bred. Collections were made in all parts of the State and local boards of health were enlisted in the service everywhere. The result was the accumulation of a large amount of material, covering every county and almost every district in the State.

Based upon these collections, it was found that the most abundant species was *Culex sollicitans,* and, after this fact was determined, especial attention was paid to the life history and breeding places of this mosquito. It has been known that the species breeds in brackish water; but it has been believed, and is so stated by Dr. Howard in his book on mosquitoes, that it would not breed in water as salty as the sea itself. Collections made along shore soon proved that this general belief was incorrect: so far as noted the contrary is true, for larvæ were found in great abundance in pools and ponds in which the water was fully twenty-five per cent. more salty than ordinary sea water. The collections in the marshes along the coast demonstrated that some percentage of salt was absolutely necessary for the development of the larvæ. In no case were

they found in fresh water, even where adults occurred in enormous quantities. This was prettily illustrated on the Elizabethport meadows, from which the cities of Newark and Elizabeth get the greatest proportion of their mosquito supply during the summer. A large portion of these meadows is flooded during extra high tides, or during storms; a number of fresh water creeks run through them and rapidly freshen these salt-water-covered areas. This is especially true during the latter part of the summer after a period of moderate tides. A two days' collecting trip by an assistant failed to develop any larvæ of *sollicitans* until the shore edge of the meadows was reached, where the puddles were distinctly salty. Everywhere else, while there were plenty of other larvæ discoverable those of *sollicitans* were entirely absent. After a heavy storm causing an unusually high tide, which flooded the meadows, collections were again made and now, as salty water was found almost everywhere, there was no difficulty in obtaining larvæ of *sollicitans*. Every attempt was made to secure *sollicitans* larvæ from fresh water; but almost without success, even where the insects occurred in swarms. I feel no hesitation in claiming that under natural conditions the larva of this species is never found in fresh water; unless it is in a pool that was salty when the eggs were laid and has been freshened subsequently by rains, or otherwise.

Another fact was established by observations made during the summer: that is, the species will travel long distances from its breeding places. For miles throughout South Jersey the only species of mosquito found in any numbers is *Culex sollicitans*. On the cranberry bogs on which I spent some time countless thousands of these insects occurred. The breeding conditions for mosquito larvæ were almost ideal and plenty of larvæ were found, but none were of this species. All the specimens observed were females; males apparently do not go away from their natural breeding places. Twenty miles back from the coast, *sollicitans* is the dominant species and occurs most of the summer. Forty miles from the coast occasional flights occur; but their period is short, rarely lasting more than a week or ten days, and there may not be more than one or two of them during the season. From observations made and information gathered along shore and back from it for some distance, it seems certain that large swarms rise during favorable evenings and are carried during the night by the wind for varying distances. The direction is determined by the direction of the wind, and may be as often out to sea as inland. Swarms have been met with fifteen miles from shore, and are common five miles from shore. These are usually if not always lost. This migration, if that term can be properly employed, is contrary to previous beliefs, my own included, and is an important factor in the question of the control of mosquitoes in the State. It takes it out of the rank of local problems and makes it a State affair. It is quite obvious that no methods adopted at a point where these mosquitoes do not breed can prevent their abundance when the wind is in the right direction to bring swarms of them from the sea coast. On the other hand, there seems to be no very great difficulty in deciding upon the character of the work that should be done to destroy the breeding places of these pests. The measures are largely of a permanent character. They consist partly of draining, partly of ditching and partly of opening ways for the free entrance of tides, and with them of certain species of small fish that feed on mosquito larvæ. At a comparatively small expense considerable areas can sometimes be freed of breeding places. Much has been done by private enterprise at seashore resorts and there will be no difficulty in se-

curing cooperation in any work that the State may undertake or may suggest.

The next species in abundance is *Culex pungens*. The history of this species has been so well written that little remains to be added to it. It is the one species of *Culex* of which we know positively that it hibernates in the adult stage. It breeds everywhere in almost all sorts of places, provided only there is water which is not salty. I have never found it in salt water; but in other respects it is not particular. It breeds in cesspools, sewage water and even in manure pits. It has no objection to remaining indoors, and the larvæ will swarm in a neglected bucket just as readily as they do in a half-filled tin can on a dump. The only point of particular interest noted in connection with this species is the fact that it breeds much later in the season than has been believed. Active larvæ were found until late in November, and even less than half-grown forms were seen at that time, indicating a comparatively recent oviposition. As against this species local work is necessary and effective; but it is far from necessary to treat indiscriminately all sorts of bodies of water. There are some places where even this insect will not breed, and unless information is generally distributed concerning the places that actually need treatment, a good deal of work will be wasted and unnecessary expense incurred.

Some very interesting information concerning the species of *Anopheles* has been gathered. It has been known that these species hibernate as adults; the places where they hibernate in the woods have been discovered; the general character of the breeding places has been established and it has been found that the larvæ may be found in salt water as well as fresh. This has been asserted of a European species but was doubted by Dr. Howard for our own. It has been also found that these insects continue to breed until long after frost has set in. Larvæ and pupæ were taken from ponds that had been completely ice covered. On at least three separate occasions adults were bred from larvæ and pupæ after they had been confined in or under ice for a period of several hours. It is demonstrated beyond peradventure that mere cold or even an ice covering is not fatal to larval or pupal life of *Anopheles*. It is further indicated from the researches made that there is absolutely no connection between the abundance of *Anopheles* and the prevalence of malaria. In a limited district where malaria as an original disease is unknown, over two thousand specimens of *A. punctipennis* were taken from the cellar under a moderate-sized farm-house. From the outbuildings as many more were captured, in October and November. Altogether about this one group of farm buildings fully five thousand specimens were actually taken during the two months mentioned. This is, therefore, one of their commonest mosquitoes; yet patients afflicted with malaria have come there, away off in the woods, to get well; and they did so, without leaving in their trail a wake of malarial cases. I do not wish to be understood as doubting the connection between *Anopheles* and malaria, nor that the mosquito is necessary as an intermediate host in the development of the pathogenic organism. I wish only to say that my investigations point to the fact that there is some other factor involved and that, even in the presence of an existing case of malaria, *Anopheles* is not able to transmit the disease to a healthy individual, unless certain other conditions favor the transmission or the development of the malarial organism after it is introduced into the healthy subject.

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Dec. 6, 1901.