

either side, just as in later days the pioneers with ax in hand chipped off the bark of the trees, and blazed their way through the trackless forests.

But what a delight the clear, cool, pure water of the Shinumo was to one who for days had been drinking the lukewarm nastiness of pool water, or the muddy and silty water of the Colorado. Not far from where we camped I found two tiny cliff dwellings, securely sheltered in the rocks above a large level area which undoubtedly had been used as a garden in years long passed.

These cliff dwellings were of that diminutive character that led the early day explorers and writers to speak of a pygmy people—dwarfs, doubtless, who alone could have dwelt in such limited space. From the Havasupais, however, I learn positively the hitherto only conjectured use of these small houses. They are not and were not dwellings in any sense of the word. They were merely used as storage houses for their corn and vegetables, and were so constructed that their produce could be safely placed therein, sealed up, and thus kept secure from the depredations of animals. A number of these small "meala-hawas" were found, and several real dwellings, but only one of the latter was accessible, and an unfortunate fall of my horse broke the plate from which I hoped to secure a good photograph of it. For ten miles we were able to follow the winding Shinumo on the trail already made, and then we came to a full stop. The old Mormon trailmaker calls this great "exclamation point" "the devil's elbow," and surely it seems a very devil of an elbow to get around. Dynamite will have to be used ere it can be passed and the upper dwellings (which can clearly be seen from walls above) reached.

Nor are these the only cliff dwellings that have not yet been explored. In one branch of the wonderful Ha-va-su Canyon (commonly known as Cataract Canyon) are scores of these dwellings and meala-hawas that no white eyes but my own (according to the statements of the Indians) have ever gazed upon. The weary work of reaching these precluded my taking the camera on my first trip beyond a certain point, where I was glad to leave it, but near here is a dwelling I hope some day to explore. It is so high up and so far within the hollowed-out walls that at present it is inaccessible.

An interesting fact about these dwellings is that the Havasupais have positive traditions as to their occupancy by their own ancestors, and, furthermore, on my last visit to this most interesting people, in July and August, 1899, I found my host, Wa-lu-tha-ma, about to go back to the cliff dwelling houses of his ancestors. Our engraving shows the site on edge of a forty or fifty feet high precipice where he was just beginning the erection of a cliff house. Though he has two wicker "hawas" in the valley, he prefers a stone house, where, as he himself informed me, he expected to be able to keep dry when it rained. Nor are these all the recent discoveries. Engraving No. 4 shows one portion of a large house near the banks of the Little Colorado which has never been explored, described or platted, and in the region of the Grand Falls and Black Falls, both on the Little Colorado, I have had the Mokis and Navahoes take me to ruins and cliff dwellings that they assure me they themselves have only recently discovered.

There is also an interesting ruin on the summit of a vast isolated rock mass, just above Willow Spring, which the Navahoes pointed out to me as I was journeying once to Lee's Ferry. This has never been described or explored. It is inaccessible, and I had to climb up the steep walls of Echo Reef ere I was able to secure a view of it.

It may be a matter of interest to show here one of the many Caveate dwellings found near Flagstaff, Arizona, and which were doubtless occupied by the same people as the cliff dwellings. The caves are either natural blowholes enlarged by rude methods or were hewn out of the softer lava deposits. Many of these caves have been explored, and the relics found are of the same character as those of the cliff dwellings.

I am satisfied there are scores of cliff dwellings in Arizona and New Mexico yet to be found, and I am glad to

have the opportunity the wide and thoughtful clientage of the SCIENTIFIC AMERICAN affords me to urge upon all travelers into this region the most thorough and careful search for places and dwellings of the prehistoric peoples regardless of the assertions made that such search will be in vain.

THE ARMAMENT OF OUR LATEST WARSHIPS.
We present illustrations of our latest long-caliber

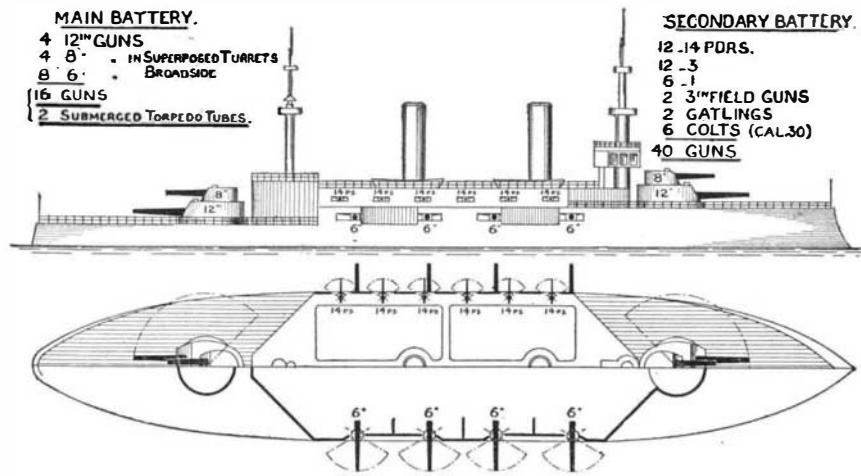
of various patterns in use during the past fifteen years, is to be found chiefly in the qualities of the powder. The old black powder of the civil war was a quick powder—the charge being almost instantly converted into gas at the instant of firing; the brown powder used in the Spanish war was slower burning than the black powder, but quicker than the smokeless powder, which burns, for an explosive, at a very slow rate, and gives off enormous volumes of gas. The slow combustion of smokeless powder necessitated a longer bore, to give the powder time to be completely consumed, and it is by the large powder chamber, big charge, slow combustion and sustained acceleration in the long bore, that the modern long-caliber gun achieves its wonderful results, the projectile of the new 6-inch gun leaving the muzzle with a velocity of 2,900 feet per second.

The accompanying diagram shows four patterns, from the 30-caliber, 4.8-ton brown powder gun, as originally carried by our earlier ships, to the new 50-caliber smokeless-powder weapon, which is to be mounted on the "New Jersey." The earlier gun of 1883 was 16 feet 3 inches long and fired a 100-pound projectile with a muzzle velocity of 2,000 feet per second and a muzzle energy of 2,773 foot-tons. Following this came the 35-caliber 5.2-ton gun, which was 18 feet 8 inches long, and gave a muzzle velocity of 2,080 foot-seconds and a muzzle energy of 2,990 foot-tons. This is the gun originally mounted on the "Oregon" and class, but since replaced by the 40-caliber, rapid-fire gun, which is 21 feet 3 inches long, and has a muzzle velocity of 2,150 foot-seconds, and a muzzle energy of 3,204 foot-tons if fired with brown powder. The 50-caliber gun is 25 feet long, and when using the new smokeless powder it will develop a muzzle velocity of 2,900 foot-seconds and a muzzle energy of 5,838 foot-tons, which is more than double that of the earlier, 30-caliber 6-inch brown powder guns of the "Boston" and "Atlanta."

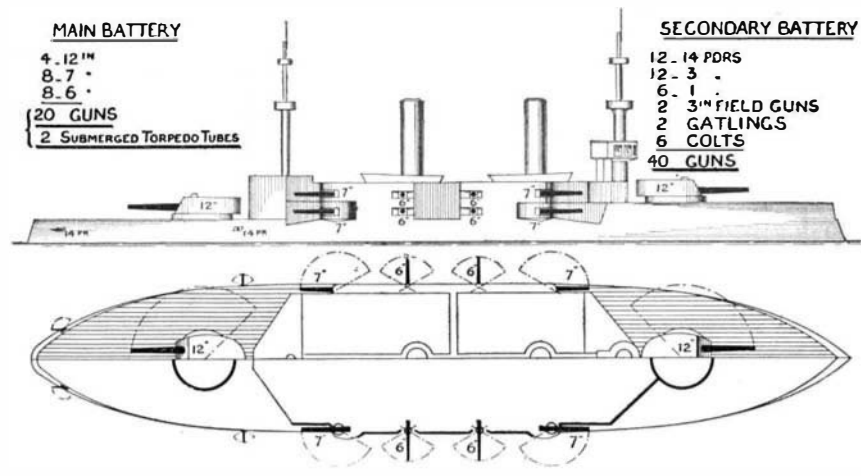
A study of the diagrams shows that the construction of our guns has been greatly simplified by the reduction of the total number of parts of which they are composed. The 30-caliber gun consisted of twelve separate pieces, whereas the new 50-caliber piece, although weighing nearly twice as much, contains only half that number. The difference is due chiefly to the improvements which have taken place in the manufacture of gun steel, assisted by the experience which has been gained in the assembling of built-up guns. The Ordnance Bureau of the navy has always claimed that it could build as efficient a gun on the built-up or hooped system as could be secured under the wire-wound system, which finds great favor in the British navy, and the behavior of our guns, coupled with the high ballistic results achieved with the latest gun, proves that their confidence was not misplaced.

The built-up gun of 1883 consisted of an inner tube extending from breech to muzzle; a jacket and a set of chase hoops shrunk on over the tube; and a set of jacket hoops shrunk on over the jacket, while over these was a ring carrying the trunnions. In the 40-caliber gun, the many chase hoops have given place to one long hoop or two, while in the 50-caliber weapon the construction is simplified to an inner tube, a single, long jacket and three jacket hoops. The substitution of a long jacket and a few long hoops for the many short hoops of the 30 caliber gun not only cheapens construction but adds greatly to the transverse strength of the piece.

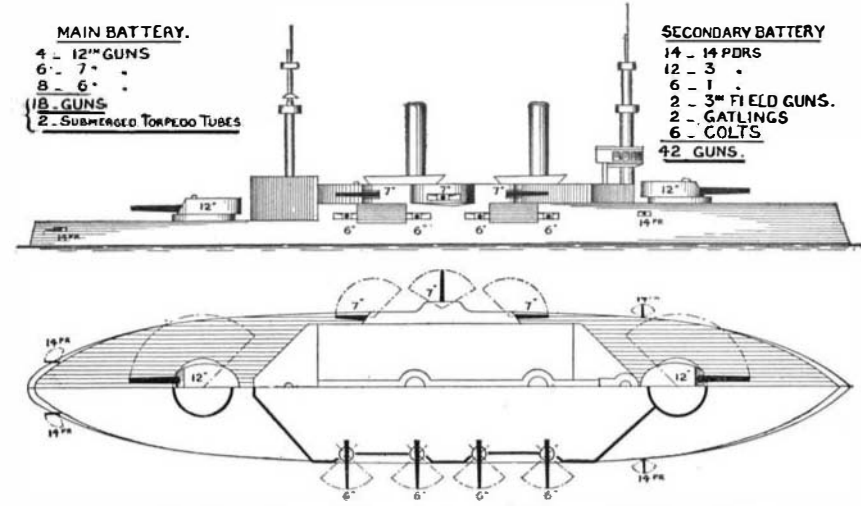
By the courtesy of Rear-Admiral O'Neil we are enabled to present the accompanying table, showing the ballistics of the new naval guns (1899 model). They are all built according to the improved principles shown in the 6-inch 50-caliber gun, and it is safe to say that as they stand on paper the results are generally equal, if not superior, to those obtained in foreign navies. The 14-pounder, 3-inch gun will form a conspicuous feature in the armament of our future ships. While by its rapidity of fire it will be suited, like the 6-pounder which it displaces, to repelling torpedo-boat attack, its power and range will render it very effective against the unarmored and lightly armored portions of an enemy's ship. The 4-inch gun



Design 1.—Armament and $\frac{3}{8}$ Ammunition 951 tons—7.03 per cent of 13,500 tons.

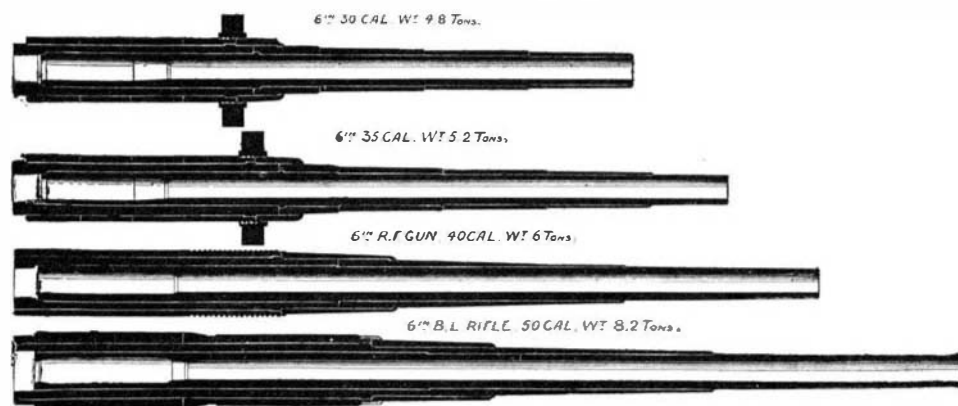


Design 2.—Armament and $\frac{3}{8}$ Ammunition 1,043 tons—7.72 per cent of 13,500 tons.



Design 3.—Armament and Ammunition 989 tons—7.32 per cent of 13,500 tons.

PROPOSED ALTERNATIVE ARMAMENTS FOR NEW 13,500-TON UNITED STATES BATTLESHIPS.



COMPARISON OF FOUR PATTERNS OF 6-INCH GUN FROM 1883 TO 1899.

guns, and also of the proposed armaments of the three first-class battleships, "New Jersey," "Georgia" and "Pennsylvania," authorized by the last Congress. In the last report of Rear-Admiral O'Neil, Chief of the Bureau of Ordnance, reference was made to the new ordnance which is being constructed for the batteries of future warships. These guns are to use smokeless powder, and develop vastly greater energy, gun for gun, than the old brown powder guns, which were so largely in use during the war with Spain.

The explanation of the remarkable changes in our navy guns, as shown in the accompanying comparison

NAVAL GUNS (MODEL OF 1899).—PERFORATION OF FACE-HARDENED ARMOR WITH SMOKELESS POWDER AND UNCAPPED* PROJECTILES.

Caliber.	Length in Calibers.	Weight in Tons.	Projectile in Pounds.	Muzzle Velocity Foot-Seconds.	Muzzle Energy Foot-Tons.	Perforation at Muzzle. Harveyed Nickel-Steel in Inches.	Perforation at Muzzle. Krupp Armor in Inches.	Remaining Velocity at 3,000 Yards Foot-Seconds.	Perforation at 3,000 Yards of Harvey Armor in Inches.	Perforation at 3,000 Yards of Krupp Armor in Inches.
3-inch.....	50	0.87	14	3,000	874	4.19	3.85	1,401	1.52	1.22
4-inch.....	50	2.56	32	3,000	1,999	6.2	4.90	1,690	2.85	2.28
5-inch.....	50	4.46	60	2,900	3,503	7.51	6.01	1,771	3.89	3.11
6-inch.....	50	8.0	100	2,900	5,828	9.35	7.71	1,893	5.90	4.24
7-inch† .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
8-inch.....	45	18.0	250	2,800	13,602	13.57	10.66	2,068	9.06	6.61
10-inch.....	40	33.4	500	2,800	27,204	18.57	14.86	2,209	13.63	10.82
12-inch.....	40	52.0	850	2,800	46,246	23.42	18.74	2,291	17.92	14.34

* With capped projectiles an increased thickness of from 15 to 20 per cent can be perforated.

† Design not yet completed.

will be mounted on our gunboats, while the 5-inch and 6-inch guns (chiefly the latter) will be used in the secondary batteries of our warships and cruisers. The 8-inch, and possibly the 10-inch, will be used for the main battery of our cruisers, and the 12-inch weapon will be the main fighting element of our battleships, although, if we follow the latest trend abroad, we may discard the 12-inch in favor of the 10-inch gun. The 12-inch gun is the most powerful weapon of its caliber afloat to-day, its muzzle energy of 46,246 foot-tons being only surpassed by the 16 and 17-inch Armstrong guns of the British and Italian navies, which have a muzzle energy of 54,000 and 55,000 foot-tons. The penetration of our gun, however, is considerably greater.

The accompanying diagrams represent proposed alternative designs for arming the 13,500-ton battleships of the "New Jersey" class, the guns to be of the new 1899 model. They were drawn up by the Bureau of Ordnance, and the amount of weight apportioned to armament is based upon the design of the "Maine," in which the weight of armament and $\frac{1}{2}$ ammunition was 1,100 tons, or 8.8 per cent of the trial displacement of 12,500 tons. Design 1 calls for the superposed turret, and is really an improved "Kearsarge," the improvements consisting of 2 knots more speed, a lofty spar deck, and the substitution of eight 6-inch, twelve 3-inch guns and twelve 3-pounders for fifteen 5-inch and twenty 6-pounders—a great increase in fighting qualities, especially if the up-to-date character of the guns is borne in mind. Design 2 calls for a new gun, the 7-inch, which does not appear in the list of new guns, as it is yet under consideration and its details are not yet determined. It will have vastly greater power and about equal rapidity of fire to the 6-inch gun, being effective against armor at ranges where the latter weapon would be useless. The eight 7-inch guns would be carried in superposed casemates at the four corners of the secondary battery, with the eight 6-inch guns mounted amidships between them. Half of these guns would be located on the main deck and half on the spar deck above. The arrangement looks well upon paper and should prove very satisfactory in practice, as the weights would be well distributed and it would be possible to concentrate two 12-inch and four 7-inch guns dead ahead or dead astern.

Design 3 is inferior in weight of armament, with two 7-inch guns omitted, and the concentration ahead or astern reduced to two 12-inch and two 7-inch.

Design 1 is the most powerful, and if the gunnery trials of the "Kearsarge" are satisfactory, it is likely to be adopted. Should it be decided to abandon the use of superposed turrets, a fine compromise could be effected by adopting design 2 with the 7-inch gun replaced by the 8-inch. The all-round fire would be the same as in design 1, and the objectionable features of the superposed turrets would be avoided.

An excellent feature in these ships is the recessed gun-ports of the secondary battery, which allow the long 50-caliber guns to be swung round, muzzle to muzzle, against the ship's side, when they are not in use. This is particularly desirable when the vessels are in harbor, or moored at a dock, the long projecting chase of a modern rifle being liable to injury from passing vessels or from cranes or other obstructions at a dockyard.

For a further discussion and fuller data respecting the new smokeless powder guns, reference is made to an article on the subject which will appear in the next issue of the SUPPLEMENT.

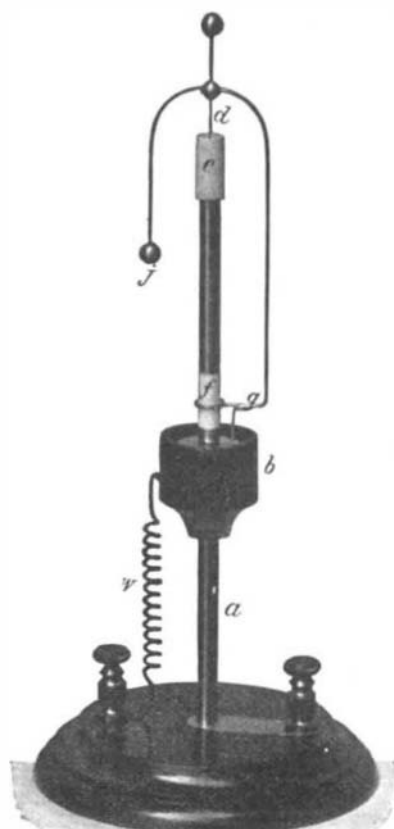
ELECTRO-MAGNETIC ROTATION.

BY HOWARD B. DAILEY.

In 1821, even before Faraday's discovery of the induction of electric currents in conductors by their movement across the lines of force of a magnetic field, this illustrious savant had shown that the reverse process was possible. Just as a wire forming part of a closed circuit has a current generated in it when forced through a magnetic field, so when a current is made to pass along a conductor placed in such a field the conductor tends to move across these lines of magnetic force. The immense importance of this discovery is recognized in the contemplation of the enormous de-

velopment of electrical power transmission of to-day. The teacher or student of physics who would demonstrate this principle in a clear and attractive way will find the easily constructed little instrument here illustrated of great value.

A permanent magnet, *a*, of quarter-inch round steel, eight or nine inches high, mounted vertically upon a suitable base, has fixed about midway between its poles a turned wooden cup, *b*, through whose bottom the rod passes. The cup contains a small quantity of mercury which is prevented from touching the magnet by a thick coating of shellac varnish which covers



ELECTRO-MAGNETIC ROTATOR.

that part of the steel surrounded by the mercury. A light brass wire frame, *c*, of the shape shown in the illustration, has soldered to its upper part a sharp pivot, *d*, made of a piece of steel needle which, projecting downward, rests in an indentation made to receive it in the top of the magnet. A short paper sleeve, *e*, fitted around the upper end of the rod and extending a short distance above it, furnishes a small recess into which a drop of mercury is placed to insure good electrical contact at this point. To steady the frame at its lower extremity the wire is bent into a loosely fitting eye encircling the magnet, from which it is here insulated by a thin paper wrapping, *f*. The small weight, *j*, serves to balance the frame and prevent undue friction at *f*. A short piece of wire bent at right and soldered to the frame at *g*, extends downward into the quicksilver,* which is electrically connected with one of the binding posts on the base by the wire, *w*, passing through the side of *b*. The other binding post is connected as shown with the lower end of the magnet. If a current from a battery be passed through the instrument, its course will be as indicated by the arrows, and the frame will rapidly revolve about the magnetic pole in a direction depending upon that of the current, thus illustrating in a simple and beautiful manner the vital principle of the modern electric motor.

THERE is a growing demand in Japan for female clerks, as for example by the Nippon Railway Company, and a special commercial education to fit them for their work is being agitated.

*The lower end of this wire, which is filed to a point and amalgamated, should only just reach the surface of the mercury, which will rise to meet it in a small cone, offering a minimum of mechanical resistance to the motion of the frame. The amalgamation is effected by wetting the point in bichromate battery solution and rubbing with quicksilver.

A New Insect Pest.

It ought to be timely now to note the result of the ravages of the new pest, *Agrilus anxius*, the borer that about two years ago attacked the ornamental white birch trees in the parks and private grounds of Buffalo, N. Y., and I do this not only as a matter of record, but to point out the degree of success and failure that attended the investigation of the case, though more especially to show what should have been done, and let our failure be a warning to other localities which are pretty sure to be visited by it later on.

Two or three years ago our resident entomologist, Mr. M. F. Adams, discovered that the white birches throughout the city were the subject of some sort of disorder, and on making a general examination, found that a great part of them were victims of a borer at that time practically unknown to science. Later on it was found that it had been described, but so obscure was its history that it had to be studied as new, although another member of the genus, *A. rubicollis*, which attacks the raspberry canes, was quite well known.

Mr. Adams at once sounded the alarm. He found no way of driving existing borers out of the trees, for though they work in the new wood just under the bark and seldom go to the heart of even small trees, they were well entrenched and so active that they fairly honeycombed the tree in a season, eating away about half of the surface wood and effectually girdling it. It was found that woodpeckers did not attack it, a fact that is hard to explain, for no borer was ever easier of access, and it was also found that there were no casts or other external evidence of their presence, which might give direction to a human warfare on them. The thing to do was clearly to destroy all trees infested by them, and as the white birch is a small tree, especially where planted for ornament, it would have been an easy task.

Still nothing was done. The city park authorities, when asked to stamp out the pest, discussed the matter and waited. Specimens of the limbs or trunks of the trees, fairly tunneled out just beneath the bark, were taken to the park office, but it was thought too bad to sacrifice the trees. The result is that nine-tenths of the city white birches are either dead or dying and the rest will soon follow. Several hundred have died, including about 50 in Forest Lawn Cemetery the present season. Even the dead trees were not burned, and the pests were allowed to multiply at will.

In its larval state *Agrilus anxius* is a thickish, brown-headed white borer about an inch long. With us it completes the circle of forms in a single year, instead of remaining in larval form a series of years, as is the habit of certain species of better-known borers. It is doubtful if any effective warfare can be waged against it without sacrificing the tree. Some effort to capture the moth by smearing the trees with a sticky substance was made, but this requires too much work. There is already an active parasite in the field, a fly not so very much unlike the ichneumon, lately described as *Phasogonfora sulcata*, and others, thought to have been described, but not yet fully identified, are making their appearance.

The speedy destruction of our trees should be taken as a warning by other localities to which the borer will migrate very soon without doubt. The lack of notice from observers to the west of us made it possible for the borer to descend upon us unannounced. It has since been found that it visited Detroit before coming here, where it does not appear to have made enough of a stir to attract outside attention. Possibly the white birch is not a very common ornamental tree there. Where the borer stopped on its way here will never be known; probably, had the route been known it would have been possible to save most and perhaps all of the Buffalo birches, especially if the public mind has been at all alert on such subjects, which, unfortunately, is not the case.

Buffalo has a young forestry association that has developed some vigor and may exert a needed influence on the inert public mind, a sample of which I will give in passing. Last spring, when the association was spraying the street trees of a member, to kill the canker worm, an offer was made to treat, free of charge, the trees of a neighbor next door, as they were badly infested, and of course a menace to the neighborhood; but the offer was rejected, and the men and apparatus were ordered off the premises. Speaking of the canker worm (*Orgyia leucostigma*), it should be remarked that it can be destroyed easily by removing the egg masses from the bodies of the trees, where they are laid by the wingless female. The worm should not be destroyed in the pupa state, as this destroys its parasite also. Observations made in Buffalo find that from 85 to 90 per cent of these worms are killed by parasites while in the pupa form.

Probably the *Agrilus* will return to obscurity by the same means, but so long as it remains active all trees infested with it should be cut down and burned while the larva is at work. Mr. Adams reports a thicket of yellow birches on the outside of the city attacked by it, and it may be that it is to spread to all species of the birch family.

JOHN CHAMBERLIN.