XVII.—*Testing the Value of Guns by Firing under Water.*

BY HENRY A. MOTT, JR., PH. D., E. M.

Read May 13th, 1878.

While investigating the force of explosives under water, with the object of perfecting a counter-torpedo for Count Kolowrat, my attention was directed by Mr. Julius H. Striedinger, the well-known civil engineer, to some experiments conducted by Maj. Gen. Uchatius,* in Austria, in regard to firing under water.

Uchatius, when reading in Jules Verne's "Twenty Thousand Leagues under the Sea," how Captain Nemo, with his involuntary guests, sheltered in a diving-bell, devoted himself to the pleasures of hunting, and how with a pneumatic gun, at a depth of 10 meters, he shot an albatross while flying a meter above the surface of the sea, asked himself the question,—Is it possible, as a general thing, to shoot under water? And, if it be so, why are not divers provided with fire-arms for defense against large fishes? It is known, says Uchatius, that fishes, if they are not too deep under the surface of the water, can be shot from the land or from boats. But it is also known that the covering of a war-ship reaches at the most only 2 or 3 meters under the surface of the water, and below this depth the ship is considered invulnerable for the greatest hostile shots; since the latter can strike only under an angle of 20 to 30 degrees, and, consequently, before their contact with the unprotected part of the ship, must have passed through from 6 to 8 meters of water.

The subject appeared sufficiently interesting to Uchatius to prompt him to conduct a series of experiments.

Under a raft built of timber, he fastened a rejected Austrian service rifle, by means of iron spans, so that when the raft floated on the water, the gun was held from 0.5m. under the water in a horizontal position. The discharge was effected

* Mittheilungen über Gegenstände des Artillerie-und-Genie-Wesens, Vol. XIII, n. 54-55.

from the shore, by means of a string. An inch plank was used as a target, which was sunk vertically in the water at a given distance from the mouth of the gun. The results of Uchatius' experiments were as follows:

At a distance of	1.5m.	(4.90 feet),		No impression.
“ “ “	1.25m.	(4.10 feet),		3 to 4 mm. deep.
“ “ “	1m.	(3.28 feet),		Pierced.

According to these experiments, a distance of .5m. decided whether there was to be any impression or whether the board was to be pierced.

These experiments being of so original a nature, and seeing in them a means of arriving at a number of important results, I determined to verify the same and elaborate upon them.

Having already constructed a tank twelve feet (3.6576m.) long by 9 feet (2.7432m.) wide by 3 feet high (.9144m.), capable of holding over ten tons (907.10528 kilogrammes) of water, I had the sides securely bolted together by large beams of wood, to prevent them from bursting out. I also had firmly constructed, within the tank, wooden rests for the guns to be used, so that there could be at least 15 inches of water over them, if so desired.

Being anxious to secure the best guns for experiments, I visited the office of the Remington Manufacturing Co., stated the object of my experiment, and Mr. Alford, the manager, kindly furnished me with guns and all the cartridges needed.

My first experiments were conducted on the 22nd of February, 1878, in the presence of Count Kolowrat, Lieutenant of the Austrian Army, Mr. Barnet Phillips of the *N. Y. Times*, and Mr. A. Alford of Remington's Sons.

Three breech-loading Remington rifles were used for the experiment:

I. THE NEW YORK STATE MODEL (or U. S. model), used at Creedmoor by the National Guards; .50 inch caliber (or 12.7mm.) Barrel 35 1-8 inch (.9017m.) long. The cartridges used were composed as follows:

PARTS.	NO. 1.		NO. 2.	
	Grains.	Grams.	Grains.	Grams.
Weight of cartridge.....	676 119	43 81	670 30	44 02
" of powder.....	68 00	4 408	68 630	4 447
" of bullet.....	480 380	29 170	480 489	29 190
" of brass case.....	182.160	9 860	166 490	10 140
" of paraffine.....	5 570	374	3 751	243
Total.....	676 119	43 81	670 30	44 02

TABLE NO. 2.

PARTS.	No. 1.		No. 2.	
	Grains.	Grams.	Grains.	Grams.
Weight of cartridge.....	778 879	50.449	765.939	49.63
" of powder.....	90.000	5.838	84 727	5.490
" of bullet.....	542.627	35.225	542.006	35.120
" of brass case.....	131.028	8.49	129.328	8.380
" of filling* and paraffine.....	14.928	.806	18.665	.855
			1 313	.083
Total.....	778.879	50.449	765.939	49.63

*The bullets were hollow to half their height—the cavity being filled with a substance resembling white lead or putty.

III. THE SPANISH MODEL—.433 in. caliber (11mm.). Barrel 35.1-8 in. (.9017m.) long.

TABLE NO. 3.

PARTS.	No. 1		No. 2.	
	Grains.	Grams.	Grains.	Grams.
Weight of cartridge.....	606 127	39.21	612.69	39.7
" of powder.....	72.4579	4.696	73.121	4.738
" of bullet.....	384 8900	24.940	388 988	25.206
" of brass case.....	144.0070	9.370	147.848	9.580
" of paraffine.....	3 1639	.206	2.793	.177
Total.....	605.1270	39.21	612.69	39.7

The target consisted of a white-pine board 3 ft. high, 10 in.

wide, and 1 in. thick; and was securely nailed upright in the tank, by means of braces, so as to afford perfect resistance to the bullet. The temperature of the water was 4° C., sp. gr. 1.000.

The rifle was placed on the supports in the tank, was loaded under water, and fired by inserting the hand and pulling the trigger. In the first few experiments the trigger was pulled by a string at a respectful distance.

EXPERIMENTS WITH RIFLE No. I.

(U. S. Model Rifle)

TABLE No. 4.

NO OF SHOTS.	AT A DISTANCE OF	REMARKS.	HEIGHT OF WATER OVER RIFLE.
1	2 feet 0 inches.	The board was penetrated	8½ inches.
2	" " 6 "	" " " "	" "
3	" " 0 "	" " " "	" "
4	" " 6 "	" " " "	" "
5	" " 0 "	" " " "	" "
6	" " 10½ "	" " " "	" "
7	" " 11 "	" " " "	" "
8	" " 11½ "	" " " "	12½ "
9	" " 11½ "	" " " "	" "
10	" " 11½ "	" " " "	" "
11	" " 11½ "	The bullet was imbedded	" "
12	" " 11½ "	" " " "	" "
13	" " 0 "	¼ inch indentation	" "
14	" " 0 "	" " " "	" "
15	" " 8 "	½ "	" "
16	" " 8½ "	" "	" "
17	" " 10½ "	1-32 "	" "
18	" " 11½ "	Indented	" "
19	" " 11½ "	No mark	" "
20	" " 0 "	" " " "	" "

EXPERIMENTS WITH RIFLE No. II.

(U. S. Army Rifle).

TABLE No. 5.

NO OF SHOTS.	AT A DISTANCE OF	REMARKS.	HEIGHT OF WATER OVER RIFLE.
1	3 feet 3 inches	The board was penetrated	5½ inches.
2	" " 5 "	" " " "	" "
3	" " 6 "	" " " "	7 "
4	" " 9 "	" " " "	6 "
5	" " 10 "	" " " "	" "
6	" " 10½ "	" " " "	12½ "
7	" " 10½ "	" " " "	12½ "
8	" " 10½ "	" " " "	12½ "
9	" " 10½ "	" " " "	" "
10	" " 11 "	Bullet imbedded	" "
11	" " 11 "	" " " "	6 "
12	" " 0 "	" " " "	5½ "
13	" " 0 "	" " " "	" "

EXPERIMENTS WITH RIFLE No. III.

(Spanish Model Rifle).

TABLE No. 6.

NO OF SHOTS.	AT A DISTANCE OF	REMARKS.	HEIGHT OF WATER OVER RIFLE.
1	3 feet 7 $\frac{1}{4}$ inches	The board was penetrated	5 $\frac{1}{4}$ inches.
2	3 " 9 $\frac{1}{4}$ "	" " " "	" "
3	3 " 10 "	" " " "	12 "
4	3 " 10 $\frac{1}{4}$ "	Bullet deeply imbedded.	" "
5	3 " 10 $\frac{1}{2}$ "	Imbedded	" "
6	3 " 10 $\frac{3}{4}$ "	" "	7 "
7	3 " 10 $\frac{3}{4}$ "	" "	" "
8	3 " 11 "	$\frac{1}{4}$ inch indentation	12 "
9	3 " 11 $\frac{1}{4}$ "	$\frac{1}{2}$ " "	7 "
10	4 " 1 $\frac{1}{2}$ "	$\frac{1}{2}$ " "	" "
11	4 " 1 $\frac{3}{4}$ "	$\frac{1}{2}$ " "	" "
12	4 " 2 "	Slightly imbedded	12 "
13	4 " 3 $\frac{1}{2}$ "	$\frac{1}{2}$ inch indentation	" "
14	4 " 5 "	Slightly imbedded	" "
15	4 " 5 $\frac{1}{2}$ "	$\frac{1}{4}$ inch indentation	" "
16	4 " 5 $\frac{3}{4}$ "	$\frac{1}{8}$ inch indentation	" "
17	5 " 0 "	1-16 inch indentation	" "
18	5 " $\frac{1}{2}$ "	1-64 inch indentation	" "
19	5 " 2 "	No mark	" "

The principal points of the above tables may be presented in a condensed form as follows:

TABLE NO. 7.

NO. OF SHOTS.	RIFLE.	AT A DISTANCE OF	IN METERS	REMARKS.	DEPTH OF WATER.
9 & 10	U. S. Model.	3 feet 11 $\frac{1}{2}$ inches	1.2019	Board was penetrated	12 $\frac{1}{2}$ in
11 & 12	" " " " " "	3 " 11 $\frac{3}{4}$ "	1.2074	Bullet was imbedded	" "
19	" " " " " "	4 " 11 $\frac{3}{4}$ "	1.5122	No mark	" "
8 & 9	U. S. Army.	3 " 10 $\frac{3}{4}$ "	1.1820	Board was penetrated	" "
10 & 11	" " " " " "	3 " 11 "	1.1894	Bullet was imbedded	" "
3	Spanish Model.	3 " 10 "	1.1844	Board was penetrated	12 "
4	" " " " " "	3 " 10 $\frac{1}{4}$ "	1.1704	Bullet was imbedded	" "
19	" " " " " "	5 " 2 "	1.5374	No mark	" "

From this table it would seem that the U. S. model is far superior to the other rifles. A board was penetrated with this rifle at 3 ft. 11 $\frac{1}{2}$ in., whilst with the U. S. Army rifle the board had to be $\frac{1}{4}$ inch nearer the rifle, or at 3 ft. 10 $\frac{3}{4}$ in., before it was penetrated; and when the Spanish model was used, the board had to be 1 $\frac{1}{4}$ in. nearer the rifle than in the first case, or at a distance of 3 ft. 10 in. This relation was true for the cartridges used, which were composed of 68 grains of powder and 450 of bullet for the U. S. model,—90 grains of powder and 542 of bullet for the U. S. Army rifle,—and 72

grains of powder and 384 of bullet for the Spanish model. The question naturally arose, what would be the relation if cartridges for each rifle were composed of the same proportions of powder and bullet. This I considered a very important problem, and I therefore submitted the proposition to prepare 25 cartridges for each rifle, to contain exactly 70 grains of powder and 450 grains of bullet each, to the Messrs. Remington's Sons, and they willingly volunteered to prepare them for me. It will be noticed from the above tables that a quarter of an inch determined in every case whether the bullet was to penetrate the board, or was to be imbedded. This may seem a very short distance, but when we consider that water is 770 times denser than the air, at 4° C., Bar. 29.922 in. (Pres. = 760 mm. of Hg.), one-quarter of an inch under water is equivalent to over 16 feet through the air. If a cartridge contains sufficient force to propel a bullet from a rifle through the air so that it will penetrate a board exactly 2400 feet away, if the board were placed 2416 feet, it would not be difficult to conceive, instead of the bullet passing through the board, of its being imbedded. Precisely the same thing happens under water; the force imparted to the bullet is quite sufficient to penetrate a board 3 feet 11 inches distant, when the U. S. Model Rifle is employed, but the force expended in travelling one-quarter of an inch farther deprives the bullet of the necessary amount of force to penetrate the board.

The preparing of the cartridges for further experiments, as I have already stated, was done for me by the Messrs. Remington. In making the cartridge for the U. S. Army Rifle, the shell, being made for 90 grains of powder, was too large for 60 grains, and consequently there would be an air-chamber between the bullet and the powder if wadding were not placed between. The first cartridges made for me contained this air chamber, but as I was of the opinion that the same amount of force would not be communicated to the bullet so effectually if the powder was in a loose state, as it would be if it were packed, the Messrs. Remington made me other cartridges with

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the powder packed with a paper wad, although Mr. Alford stated to me that it was the impression of sportsmen that there would be no difference. I decided therefore to test this point by actual experiment. To prepare cartridges for the Spanish model would have involved considerable extra expense; I therefore concluded to substitute a Sharp's Rifle of .50 in. caliber.

The cartridges were composed as follows:

TABLE NO. 8.
(SEE TABLES 1, 2, 3.)

PARTS.	I. CARTRIDGES FOR .50 CALIBER.		II. CARTRIDGES (air) FOR .50 CALIBER.		III. CARTRIDGES FOR .58 CALIBER.	
	Grains.	Grams.	Grains.	Grams.	Grains.	Grams.
Weight of cartridge.....	648.03	41.99	669.94	43.41	695.43	45.061
" of powder.....	70.22	4.55	69.91	4.53	70.10	4.548
" of bullet.....	480.18	29.17	449.75	29.142	447.85	29.019
" of shell.....	128.65	8.20	147.23	9.54	161.82	10.485
" of paraffine.....	.08	.07	3.05	.196	13.81	* 895
" of wad.....					1.78	.114
Total.....	648.03	41.99	669.94	43.41	695.43	45.061

* Wad.

The following tables contain the report of my experiments conducted with the new cartridges, on May 4th.

Temperature of the water, 19° C., or 66.2 F.

EXPERIMENTS WITH THE U. S. ARMY RIFLE.

TABLE No. 9.
Height of water above the rifle, 11½ inches, in each case.

NO OF SHOTS.	CARTRIDGES WITH THE POWDER PACKED. DISTANCE.	CARTRIDGES WITH THE POWDER LOOSE. DISTANCE.	REMARKS.*
1	8 feet 10 inches.....	8 feet 10 inches.....	¼ inch indentation
2	8 feet 9½ inches.....	8 feet 9½ inches.....	1-32 inch indentation
3	8 feet 9½ inches.....	8 feet 9½ inches.....	Penetrated the board
4	8 feet 9½ inches.....	8 feet 9½ inches.....	Imbedded
5	8 feet 9½ inches.....	8 feet 9½ inches.....	Imbedded
6	8 feet 9½ inches.....	8 feet 9½ inches.....	Imbedded
7	8 feet 9½ inches.....	8 feet 9½ inches.....	Imbedded
8	8 feet 9½ inches.....	8 feet 9½ inches.....	Imbedded
9	8 feet 9½ inches.....	8 feet 9½ inches.....	Imbedded
10	8 feet 9½ inches.....	8 feet 9½ inches.....	Imbedded
11	8 feet 9½ inches.....	8 feet 9½ inches.....	Imbedded
12	8 feet 9½ inches.....	8 feet 9½ inches.....	Imbedded
13	8 feet 9½ inches.....	8 feet 9½ inches.....	Imbedded
14	8 feet 9½ inches.....	8 feet 9½ inches.....	Imbedded

* Quite a difference in effect will be noticed between the same cartridge in the second and third columns of the table, owing to the powder being loose.

EXPERIMENT WITH SHARP'S RIFLE.

Caliber .50 in., or 12.7 mm. Barrel 30 1-8 inches. The cartridges used have the composition in the above table, No. 8, first column.

TABLE NO. 10.
Height of water above the rifle, 11½ inches.

NO. OF SHOTS.	DISTANCE.	REMARKS.
1	3 feet 10 inches.	Penetrated the board.
2	3 " 11½ "	" " "
3	3 " 11½ "	" " "
4	4 " ½ inch.	" " "
5	4 " 1 "	" " "
6	4 " 1½ "	" " "
7	4 " 1½ "	Deep indentation.
8	4 " 2½ "	½ in. indentation.

EXPERIMENTS WITH U. S. MODEL RIFLE I.

TABLE No. 11.
Height of water above the rifle, 11½ inches.

NO. OF SHOTS.	DISTANCE.	REMARKS.
1	4 feet 0 inches	Penetrated the board.
2	4 " 1½ "	" " "
3	4 " 1½ "	Imbedded.
4	4 " 2 "	"

The height of the water above the rifle in all cases 11½ inches.

NO. OF SHOTS.	RIFLE.	DISTANCE.	REMARKS.
3	U. S. Army Rifle	3 feet 9¼ inches	Powder packed.—Board penetrated.
6 and 7	" " "	3 " 9¼ "	Imbedded.
"	" " "	3 " 8½ "	Powder loose.—Board penetrated.
14	" " "	3 " 8½ "	Deeply imbedded.
5	Sharp Rifle	4 " 1½ "	Board was penetrated
7	" " "	4 " 1½ "	Deeply indented.
2	U. S. Model	4 " 1½ "	Board was penetrated.
3	" " "	4 " 1½ "	Imbedded.

*As the cartridges ran out, I was unable to try this experiment; but as the bullet was almost through at 3 feet 8½ inches, my experience indicates that at 3 feet 8½ inches, the bullet would have penetrated the board.

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On carefully examining the figures in this table, it will be seen that when the U. S. Model rifle or Sharp's rifle is used exactly the same results are obtained; that is to say, the board would be penetrated at a distance of 4 feet 11-2 inches, while in the case of the U. S. Army rifle, with the packed cartridge, the board had to be 17-8 inches nearer the rifle, or at a distance of 3 feet 9 5-8 inches. One inch and seven-eighths through water is equivalent to 120.31 feet through the air; it seems, therefore, that the U. S. Army rifle is very inferior to the other two. Even with 90 grains of powder and 542+ grains of bullet, as shown by Table 7, it is greatly inferior to the U. S. Model.

On examining the shape of the bullets employed, I found that while the bullets used in the cartridges for both the U. S. Model and Sharp's rifles were conical, those employed in the cartridges for the army rifle were quite blunt. Fearing that the shape of the bullet offered some resistance to its progress, I carefully cut the bullet of the army rifle cartridges quite conical, but found in several experiments, that only a difference of 3-8 of an inch was made;—that is to say, that when the blunt bullet was used, the board was penetrated at 3 feet 9 5-8 inches, and when the conical bullet was used, at 3 feet 10 inches.

When cartridges were used containing the powder loose, by examining Table 12 it will be seen that the results are very variable, and that the board had to be 1 1-8 inch nearer the rifle, before it could be penetrated.

In the following table are given the results of the four rifles used for experiments, compared with the Austrian Service rifle.

TABLE 13.

NAME OF RIFLE.	PENETRATED THE TARGET AT	WEIGHT OF POWDER.	WEIGHT OF BULLET.	REMARKS.
U. S. Model.	3 ft. 11½ inches.	68 + grains.	450 grains.	See Table 7 & 1.
U. S. Model.	4 " 1½ "	70 " "	460 "	" " 11 & 2.
Sharp's Rifle.	4 " 1½ "	70 " "	450 "	" " 10 & 2.
U. S. Army Rifle.	3 " 10½ "	90 " "	542 "	" " 7 & 2.
U. S. Army Rifle.	3 " 9½ "	70 " "	460 "	" " 9 & 2.
Spanish Model.	3 " 10 "	72 + "	364 "	" " 7 & 3.
Austrian Rifle.	3 " 3½ "			By Uchaitus.

It will be seen from this table that the U. S. Model (N. Y. State Model) and Sharp's rifle come first; then the U. S. Army rifle; next the Spanish Model; and last the Austrian Service rifle. The experiments made by Uchatius with this last weapon were very limited; for example, he did not determine the distance that established the fact, whether the bullet is to penetrate the board or is to be imbedded; he consequently did not arrive at the true value of the rifle as regards penetration; and as the weight of powder and bullet were not given in his report, it is hardly fair to consider the Austrian rifle inferior to those that I tested, until more exact experiments are conducted with it.

It now becomes necessary to investigate also the cause of the variation between the different rifles experimented with. It will be remembered that in the first part of my paper I stated that my object was to verify the experiments of Uchatius. I therefore adopted as much as possible the conditions under which he worked. For instance, he says, "the distances were measured from the *mouth* of the gun." From the description given of the rifles used by me, it will be seen that the length of barrels differed; while in the U. S. Army rifle the barrel was 39 1-8 inches long, that of the U. S. Model and Spanish Model was 35 1-8 inches, while that of the Sharp's rifle was only 30 1-8 inches. It will be evident, as all my measurements were taken from the end of the barrel—instead of from the end of the cartridge,—that the bullet in the barrel of the greatest length had to travel through more water (in the barrel) than in a barrel of less length.

From the above illustration it will be seen, supposing the cartridges to be all of the same length, that the bullet in the U. S. Army rifle had to travel through (39 1-8—35 1-8) 4 inches more water than in the U. S. Model rifle, and that the bullet from the Sharp's rifle did not have to traverse as much water by (35 1-8—30 1-8) 5 inches, as the bullet of the U. S. Model rifle. Correction must therefore be made, before any true comparison of the rifles can be reached. With respect to the cartridges, also, some correction must be made, as they are not of the same length.

CARTRIDGES.

It is evident that if the measurements are taken from the cartridge, they must be from that part of it which fits the barrel, and not from the end of the bullet; as the bullet has a more or less conical shape, it is therefore surrounded by water when the rifle is submerged. In the cartridges for the U. S. Army, U. S. Model, and Sharp's rifles, the end of the metallic case is

RIFLE.	FINAL DISTANCE.	CORRECTED DISTANCE.	REMARKS.
U. S. Army Rifle.....	3 ft 9½ inches	4 ft. 1 11-16 inches	Board was penetrated
" " ".....	3 ft. 9¼ "	4 ft. 1 12-16 "	Bullet was imbedded
U. S. Model Rifle.....	4 ft. 1½ "	4 ft. 1¼ "	Board was penetrated
" " ".....	4 ft. 1¾ "	4 ft. 1¾ "	Bullet was imbedded
Sharp's Rifle.....	4 ft. 1¾ "	3 ft. 8½ "	Board was penetrated
" " ".....	4 ft. 1¾ "	3 ft. 8½ "	Bullet was imbedded
*Spanish Model.....	3 ft. 10 "	3 ft. 10 3-16 "	Board was penetrated
" " ".....	3 ft. 10¼ "	3 ft. 10 7-16 "	Bullet was imbedded

TABLE No. 15.

RIFLE.	DISTANCE THROUGH WATER.	DISTANCE THROUGH AIR.
U. S. Army Rifle.....	4 feet 1 11-16 inch.	3182 54 feet.
U. S. Model Rifle.....	4 feet 1 1/4 inch.	3176.25 feet.
Sharp's Rifle.....	3 feet 8 1/2 inch.	2865.41 feet.
Spanish Model.....	3 feet 10 3-16 inch.	2962 13 feet.

From this table it appears that the bullets from the U. S. Army rifle will penetrate a board through the air at 6.29 feet farther than when the U. S. model is used, and 327.13 feet farther than when the Sharp's rifle is used, with the same weight of powder and bullet.

In conclusion, I would remark that there can be no doubt, if the subject of firing submerged arms is understood and appreciated, that in the future, when an arm is to be tested, instead of firing in the air, it will be fired under water; and that as the editor of the 'Forest and Stream' says, "long ranges for testing rifles will be supplanted by water tanks." With respect to the tank, a word or two may be of advantage.

It should be about 12 feet long by 2 feet wide by 3 feet high; and if made of wood, the wood must be at least two inches thick, and the sides securely bolted together. As water is only very slightly compressible, it will readily be understood that, when the gun is fired, the force of the explosion is at once communicated to the sides of the tank, and unless they are securely bolted they will be readily broken apart. The tank could be made of iron, or could have heavy plate glass sides in an iron frame, when the bullet could be seen to drop.

By the use of this method, range and penetration can be arrived at with the greatest precision;—also the value of the numerous gunpowders in the market can be accurately ascertained, as well as the maximum effect from the minimum amount of powder. The best weight of bullet for a given weight of powder, the best length and bore of barrel for a given weight of powder and bullet, and the actual range of a given cartridge,—all these determinations can be made in a room less than twelve feet square.

The height of water over the rifle, according to my experiments, makes no difference, as the same results were obtained when the rifle was submerged five inches as when submerged 12 inches. This is not singular, when we consider the rapidity with which the bullet travels and the short time the column of water has to act on it. The cause of the limited range under water, then, is the fact of the motion of the bullet being opposed by a medium of much greater density than the atmosphere.

The variation between different rifles, from my experiments I have been led to believe, is due in part to differences in the length of barrel, in the size of bore, and in the internal structure of barrel; but more particularly to the fact that as a rule the amount of powder and bullet are not only in absurd relations to each other, but are not in correct proportions for the length and bore of barrels peculiar to different rifles. These facts only demonstrate that there is a large number of very important points yet to be examined.

XVIII.—*The Fungi of Texas.*

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The following is an enumeration of all the species of Fungi which, so far as I am aware, have hitherto been detected in Texas. In addition to the few collected by Wright and others, and mentioned in Berkeley's *North American Fungi*, a small collection of two hundred specimens, gathered a few years since by Mr. H. W. Ravenal, has been examined; and after the determination of these, the whole number of species does not exceed one hundred and fifty. This is a very poor catalogue for a State which is undoubtedly rich in these plants; but the enumeration will possess an interest and a