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The British-Italian Performance in the Mediterranean from the Artillery Perspective

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Abstract

The Italian defeat in the Second World War was a consequence of its failure to dominate the central Mediterranean. In the numerous works that address the issue, scholars tend to see reasons of a political nature, shortcomings in the organization and planning by the Italian Navy, indecisive political leadership, and so on. But all agree that technically the Italian fleet was superior to British ships deployed in the Mediterranean area, and in this regard the defeat of the Italians is seen as paradoxical. In this paper, the authors explore the theory that the poor showing of the Italian navy may have resulted from the errors of the political, military and technical leadership in the prewar period, in particular in the performance of the Italian naval artillery.

Keywords: *Mediterranean history, naval history, Italy, Great Britain, historical reconstruction.*

Introduction

In recent years the phrase 'technical innovation' has been widely used in the literature or for various purposes. But nevertheless, there is an undeniable connection between social evolution and technical innovation. Probably, one can find the most original presentation of this relationship in *Theory of Cultural Circles* by Fritz Graebner (*Methode der Ethnologie*; see Graebner 1911). When analyzing ancient and medieval data, it is easy to notice that progress in technical areas, especially in military technology, could give the possessors of these innovations a decisive advantage over other nations, contribute to the conquest and exploration of new territories, and insure a certain domestic tranquility. Also there is no doubt that the level of innovation is 'cumulative'; each subsequent military innovation is much more effective than the previous one. Nor is there any doubt that a continual innovation became the key to survival. For instance, in the twelfth century, Saladin's Moslems perfected the horse archer regarding it as the ultimate weapon. Thereafter, the innovation in the military sphere virtually ceased, and the Muslim states thus missed out on the developments in gunpowder weapons.

The twentieth-century data brought about some changes in this coherent theory. It turned out that the nature of technical innovations varies, which is most clearly demonstrated by the evolution of naval artillery. Because of the high cost, hardly anyone, even the richest state, could afford to evolve artillery by trial and error or aesthetics, but had to develop and strictly adhere to a certain doctrine, referred to in the literature as 'technology policy'. For example, advances in development of propellant powders and artillery materiel in the beginning of the twentieth century was applied to create a new generation of artillery for high muzzle velocities and therefore, better ballistic performance. And it became possible to design artillery with the performance of the previous generation, but much easier and simpler to produce, and hence less expensive. In this case, there seems to be a continuing conformity with the 'cultural circles', though this is an illusion. It was just the high cost and complexity of the twentieth-century artillery technology that turned out to be a trap in innovation. If the underlying facts and theories for a particular technology policy decision subsequently prove to have been incorrect, the resulting material must still be used until it can be replaced, with corresponding performance issues. Making a wrong choice in policy has serious and costly consequences.

To illustrate the effect of such a highly subjective characteristic as 'technology policy' at the macro-level, one needs merely to look at the combat operations in the Mediterranean theater of the Second World War. The most characteristic feature are the operation in 1940–1943, the period of active participation in the war at sea in Italy. In the late 1920s and 1930s, Italy had been virtually isolated from the influence of external military innovation, primarily German and American. And in point of fact, the Italian ordnance technology had its origins in the British firms such as Armstrong/Elswick and Vickers in the late nineteenth century, which continued through and immediately following the Great War, after which the source 'dried up' and left the Italians to their own devices. So, in a general sense, their ordnance of the Second World War predominately reflected the Italian policy decisions.

Perhaps, more than any other form of combat, naval warfare is dominated by technology. For example, the naval engagements of the Russo-Japanese War (1904–1905) may be viewed in terms of French and French influenced technology *versus* British technology. In a like manner, the combat in the 1940–1943 period compares the products of Italian *versus* British technology. At stake was control of the central Mediterranean, necessary to provide the ability to supply and reinforce the military forces in North Africa.

Historical Note

The naval war in the Mediterranean Sea from 1940 to 1943 is still the subject of much controversy, revolved not so much about what actually happened, but rather *why* the campaign proceeded the way it did, and the various engagements so unsatisfactory for the Italian *Regia Marina.* There are many theories, and this paper and model explore one of them.

The *Regia Marina*. The strategic situation of the Italian military in 1940 was the one of dominating the central Mediterranean, from roughly Algiers to Tripoli. And this was improved considerably in the spring of 1941 with the conquest of Greece and Crete, which extended their presence as far as Benghazi, with a combination of air power and naval power.

The main power of the *Regia Marina* was four extensively re-built and thoroughly modernized fast battleships from the Great War. More properly, these should probably be considered as battle-cruisers due to their high speed and relatively light armor protection. Four very powerful modern fast battleships of the *Littorio* class, two of which would join the fleet in 1940, and the other two scheduled for completion in 1942. In the event, only *Roma* would be completed on time, with *Impero* still fitting out slowly in September 1943 (Gardiner 1980).

These were backed by seven heavy cruisers armed with 8-in (203-mm) guns, completed between 1928 and 1933, and twelve light cruisers armed with 6-in (152-mm) completed between 1931 and 1937. Twelve extremely fast unarmored scout cruisers were laid down in 1939, but only three were completed before the Italian surrender.

Sixty well armed destroyers, launched between 1925 and 1943, and sixty five torpedo boats, which could also be classified as destroyer escorts or corvettes, were launched between 1937 and 1943.

The *Regia Marina* had adopted a high velocity / heavy projectile combination for their naval guns, first used with the 12-in (304.8-mm) guns of 1909. This would provide good range and good armor penetration. With the modern guns, it was quickly apparent that the dispersion pattern was too great, so the muzzle velocity was reduced without completely fixing the problem. The Table below gives the original MV and the reduced MV, with comments as applicable.

Table 1. Ballistic information of Italian guns

Gun	Original MV (m/s)	Reduced MV (m/s)	Notes
381 mm / 50	870	850	
203.2 mm / 50	905	840	With new lighter shell
203.2 mm / 53	960	900	With original heavy shell
152.4 mm / 53	1000	850	
120 mm / 50	950	920	

The 320-mm / 43.8 (bored out 304.8-mm / 46) were quite good. With a muzzle velocity of 830 m/s, their shooting was good and the initial patterns were very tight; so tight, in fact, that they were adjusted to be larger. The 6-in / 55 (152.4-mm) had a muzzle velocity of 910 m/s, which was left unchanged. The new 135-mm / 45 (5.3-in) had a muzzle velocity of 825 m/s and shot well. Doctrine called for firing by turret with a several second interval. For a three turreted ship, the order would be A, C, B. For a four turreted ship it would be A, D, and C and B together. Cruisers with twin turret mounts would be A, D, C, B.

Fire Control was one of the RM's strong points, and their equipment and system were excellent. While they were late developing radar, they had fully developed the concept of the Fire Control Central, which featured the Director, computing machinery, inclinometers, follow-the-pointer gear, and range finders, all of a very high quality. They had also developed the concept of scartometry, by means of which the fall of shot was ranged with a stereoscopic range finder and the results compared to the calculated gun range. This would measure the variance and provide the correction. Problems with Italian gunnery cannot be blamed on their fire control suite (O'Hara 2009).

The Royal Navy. Great Britain had a vastly larger navy than Italy. But they also had many commitments for their finite resources, which included keeping a viable force at each end of the Mediterranean, so they were perpetually numerically inferior to the *Regia Marina.*

The main strength of the RN in 1940 consisted of the five *Queen Elizabeth* class battleships, four of which had fought at Jutland in 1916. Two of them had been reconstructed and modernized, while the other two had not been, and remained little improved. The fifth, the famous *Warspite*, which had been reconstructed to a slightly lesser extent than the other two, engaged Italian warships on several occasions. There were also the four surviving *Revenge* class, two of which had been at Jutland. They had not been modernized, and were decidedly inferior at modern battle ranges. The two ‘Treaty’ battleships completed the battle line. The new fast battleship *King George V* joined the fleet in 1940. There were additionally the battle-cruisers *Hood, Renown* and *Repulse*, the last two very lightly protected and under-armed. However, *Renown* had been thoroughly reconstructed and modernized, and was often attached to Force H out of Gibraltar (Gardiner 1980).

The Royal Navy also had many modern heavy and light cruisers and destroyers. Losses had been heavy, especially around Crete. Thus the make-up of these light forces changed frequently throughout the period.

British naval guns were of good quality. The performance was moderate, so they were often theoretically out ranged by their opponents, though not so in reality. In fact, *Warspite* scored one of the two longest range hits during the war. Their projectiles, however, were first rate, and always seem to have performed well. Doctrine was for fairly tight patterns with ‘half’ salvos.

The RN's fire control was one of their strong suits. They were well ahead in the development of radar, and all the cruisers and capital ships had elaborate equipments for solving the gunnery problem. All the un-reconstructed ships were fitted with the Dreyer Fire Control Table Mk. V, or as modified over the inter-war years. The new ships and those that had been reconstructed were fitted with the Admiralty Fire Control Table (AFCT), which was a post-Great War development, as did most of the modern cruisers.

The Royal Navy was not 'flashy' in its ships and guns. Rather, they sought consistency and high quality throughout. It should be remembered that the brand new, untried and not even properly worked up *Prince of Wales* scored against *Bismarck* in spite of equipment breakdowns and other problems with the gun turrets.

None of the engagements between the heavy ships was fought to a conclusion, and all were at long range. Neither side has a significant advantage in fire control. This is to say that the RN advantage of radar would have been offset by the RM's scartometry. The RM enjoyed, on the whole, the advantage of more powerful guns. This, however, meant nothing in view of the overly large dispersion patterns.

Research

Marc Antonio Bragadin's *The Italian Navy in World War II* (Bragadin 1997) is bewildering. Their 'greatest' victory was Pantellaria, in which a British destroyer and several transports were sunk. But given the correlation of the forces involved, they should have exterminated the entire convoy to the last vessel! And the 'super fast' Italian ships would never catch the much slower British vessels; *Bartilomeo Colleoni*, supposedly capable of 40 kts, was savaged by HMAS *Sydney*, which on her best day made only 32 kts.

How could it be that with the larger fleet, magnificent artillery and well-trained crews the Italian Fleet suffered one shattering defeat after another? Let us try to look at the problem through the prism of naval guns.

For the purposes of comparison, we shall select three artillery systems that were nearly analogous between the two navies: the 381-mm (15") main guns of the battleships, 203-mm (8") guns of the heavy cruisers, and the 152-mm (6") of the light cruisers. The performance of each is summarized below.

Table 2. Characteristics of British and Italian guns (Campbell 1985)

Caliber	Model	Shell weight, kg	Muzzle velocity, m/s	Form factor to the Law of 1943
152/50	Mk XXIII	50.8	841	1.08
203/50	Mk VIII	116.1	855	1.03
381/42	Mk I	871.0	752	1.27
152/53	Model 1926	47.5	1000	1.09
203/53	Model 1927	125.3	955	1.09
381/50	Model 1934	885.0	850	0.89

The technique and functions for ballistic calculations was presented in sufficient detail on the pages of *Warship International* in the article by William Jurens (1984). Many of the functions are of an empirical character, and thus differ a little bit for each country. So in Russia the definitions of a standard atmosphere were set forth in the Russian State Standard 4401–78, which defined the character of temperature variations, density, viscosity, and air pressure at altitude functions. These are the functions used for this analysis. And for the laws of resistance the following were applied:

– Law of Siacci (for shells of a form similar to the standard Type 1);
– The Law of 1930 (similar to Type 8);
– The Law of 1943 (similar to Type 7).

In this case for the definition of the form factor of a shell, the Law of 1943 was employed. From Table 2, it is evident that the British and Italians have used shells with almost identical ballistic properties. However, here there is nothing unusual, as the British influence on Italian ordnance was really significant. Up to the end of WWI, the guns of the Italian fleet were made under license to designs from the firms of Armstrong (EOC) and Vickers. And as a matter of fact, subsequent gun developments were modern versions of those designs. This connection, by the way, shows rather exponential comparison of the form factors for shells of the main guns of the leading maritime states. For example, for guns of about 127-mm (5") which were introduced into the inventories during the 1920–1930s, as the main guns for destroyers, the values are as follows (using the Law of Siacci):

Table 3. Characteristics of destroyers' guns of the world

System	State	Muzzle velocity, m/s	Shell weight, kg	Range for elevation, m	Form factor to the Siacci's Law
120/45 Mk I, Mk II	Britain	814	22.70	14,450 (30)	0.82
130/40 Model 1924	France	725	34.85	18,700 (35)	0.60
127/45 SK C/34	Germany	830	28.00	17,400 (30)	0.66
120/50 Model 1926	Italy	950	23.15	22,000 (45)	0.62
120/45 Type 3	Japan	825	20.41	16,000 (33)	0.66
130/50 B 13	USSR	870	33.40	25,730 (45)	0.52
127/38 Mk 12	USA	762	25.04	15,300 (35)	0.73

From the above table, taken from Tony DiGiulan's contributions to the Warships1 website (www.warships1.com), the ballistics of guns of the main European states and Japan were at approximately the same level. It is interesting to note, however, that the Soviet shell had the best ballistic form. But this should not be surprising, as the attention given to ballistics in the USSR, which resulted in the M.1928 pattern projectiles, is well known now. Stalin even took a personal interest in the development program, which produced gun systems equal or superior to all foreign designs in all main parameters save one – barrel life. This unfortunately cancelled out all of their virtues, as the Effective Full Charge life of the gun was equal to the capacity of the magazine!

The American and British guns have the worst ballistics form, but this cannot be the only criterion, since doctrine required the more universal application of both anti-surface and anti-air capabilities.

But to return to the Anglo-Italian conflict in the Mediterranean, it is well known that the hit probability is determined in large part by the angle in descent of a shell, known as the Danger Space. Steve McLaughlin (2001) defined this relationship as:

Danger space = Target width + Target height / Tangent of Angle of Descent.

It follows, therefore, that the lower the angle of descent, the greater the hit probability, which is the rationale behind the use of high velocity guns. Fig. 1 reflects this parameter of the major British and Italian guns.

As is depicted in Fig. 1, at all battle ranges the angle of descent of the Italian shells is less than that of their British opposite number. Indeed, at ranges up to 16,000 m, the angle of descent of the Italian 203-mm shell is less than that of the British 381-mm!

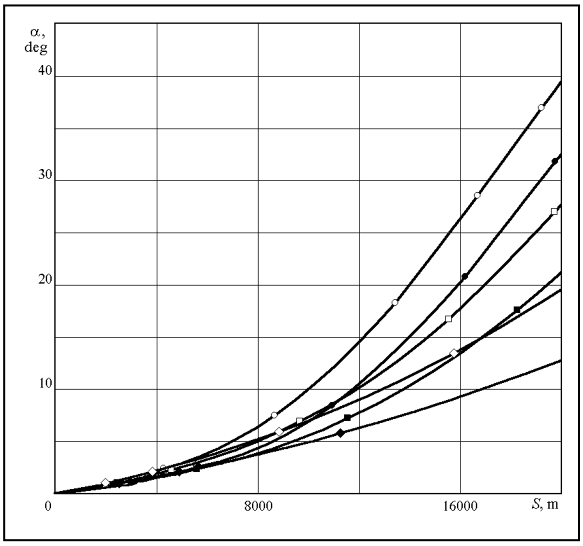

Fig. 1. Comparison of angle of incidences of shells[1]

If comparison were only limited to the size of the danger space, than the Italians should have enjoyed a considerable advantage. This makes the results of the gun

[1] For all figures: circle are 152-mm guns, square are 203-mm, rhombus are 381-mm guns; white for British systems, black for Italian systems.

battles quite paradoxical. Therefore, as a second step we must try to estimate the values of the ballistic corrections. A technique for obtaining such values would be to determine the effect of corrections in an elevation angle: the variation of an elevation angle is applied, which affects the range. Thus, for each degree of deviation either way, the shell either falls short or flies over by a certain number of meters. Other corrections produce a similar result. The unique exception is a variation of the atmospheric density and pressure, the values of which are generally included in the Range Tables. The given technique was approved by the authors on the basis of Range Tables (see TS-146 1971) for the 122-mm Soviet howitzer, model 1938, and has given satisfactory convergence.

1) Correction of elevation angle – its physical sense is sensitivity of the gun to the roll of the ships (see Fig. 2). Though Fire Control Suites were common before the War, the very sensitive instruments that appeared only afterwards had effect as if the ship were on an even keel, the consequences of roll being eliminated insofar as the guns were concerned. But in the absence of such systems, the divergence between the British and Italian guns is most obvious in the performance of the 381-mm guns. Dispersion of the Italian shells was almost 1.5–2 times greater! This means that in the presence of virtually any wave activity at sea (which is almost always), the British would have on average twice as many hits as would the Italians!

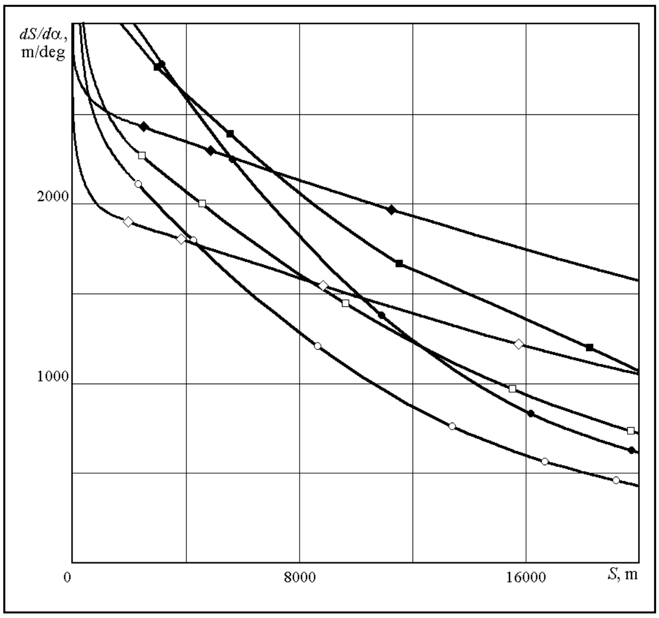

Fig. 2. The correction on an elevation angle

2) Correction for the mass of the shell – sensitivity of the gun to the 'know-how' of shells (see Fig. 3). As is known, the more developed manufacturing processes warrant obtaining smaller tolerances. Thus, dispersion due to variation of the mass of the shell is lower, as the shells are more uniform. However, as Jack Greene and Alessandro Massignani (see Greene and Massignani 1998) have pointed out in their *The Naval War in the Mediterranean 1940–1943*, manufacturing tolerances in the production of the Italian shells were overly large on the one hand, as was the weight control of the propellant used in bagged charges.

The Table below shows the changes in range caused by a mere one per cent variance in shell weight and propellant charge weight.

Table 4. Changes in range caused by a per cent variance in shell weight and propellant charge weight

Condition	Shell weight (kg.)	MV (m/s)	Range at 15-deg. elevation (meters)
Range with 0 % increase	885	870	26,420
1 % increase in charge	885	874.34	26,640
1 % decrease in charge	885	865.64	26,201
1 % increase in shell wt.	893.85	865.68	26,289
1 % decrease in shell wt	876.15	874.38	26,552
1 % increase in both	893.85	870	26,507
1 % decrease in both	876.15	870	26,332
1 % increase in charge & 1 % decrease in shell wt	876.15	878.74	26,772
1 % decrease in charge & 1 % increase in shell wt	893.85	861.34	26,070

So even though it may have been possible for the Italians to have adjusted for the variations in shell weight, which were often labeled on the projectile and allowed for in the Range Tables, the variation in the propellant charges could not. Thus the Italians were laboring under an additional burden with regard to dispersion.

3) Correction for atmospheric pressure (see Fig. 4). In this area, the change in condition would affect both sides, with neither obtaining a material advantage. Thus, the value of this correction is not so great, as atmospheric pressure varies rather slowly, which allows for its rather exact measure.

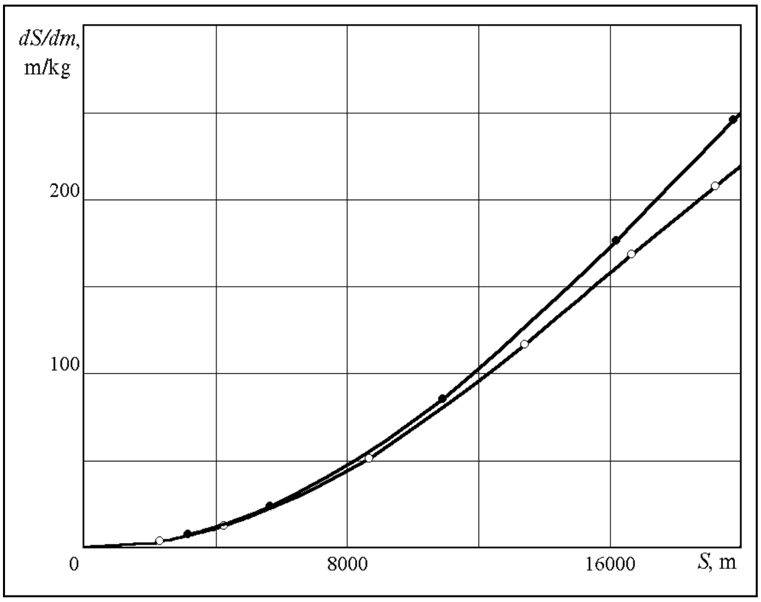

Fig. 3a. The correction on a mass for 152-mm shells

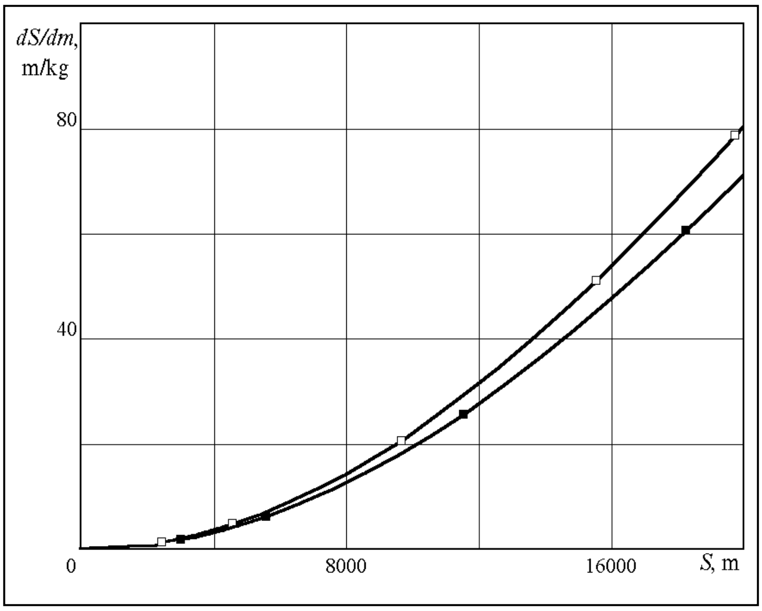

Fig. 3b. The correction on a mass for 203-mm shells

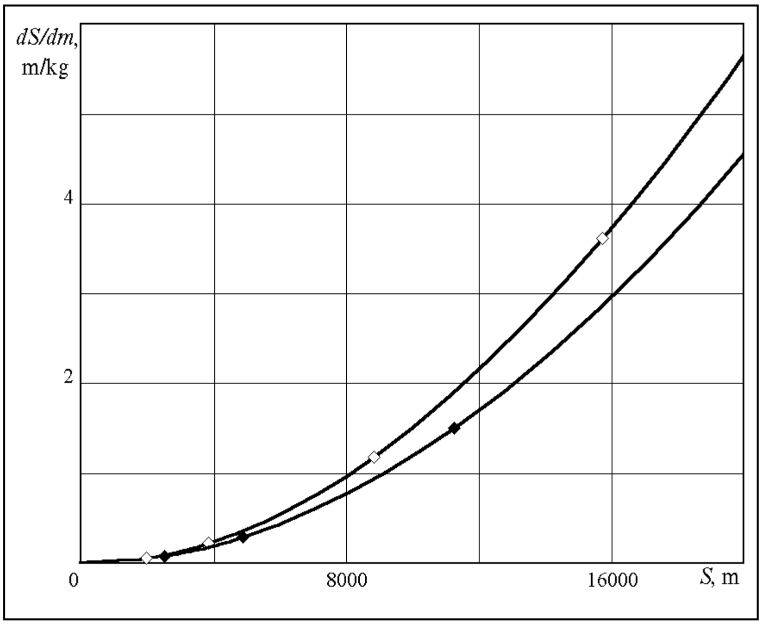

Fig. 3c. The correction on a mass for 381-mm shells

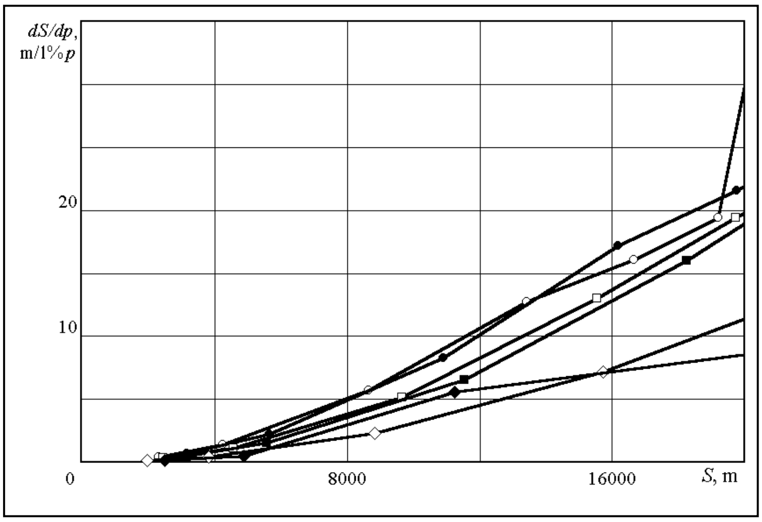

Fig. 4. The correction on atmospheric pressure

4) The correction for atmospheric density actually displays sensitivity of the gun to meteorological conditions, as the presence of rain or snow results in increased density of the air (see Fig. 5). This correction, as opposed to atmospheric pressure, is rather difficult to take into account. Sudden rain or snow showers (the latter not common in the Mediterranean), or fog, would have a detrimental effect on ballistic performance. But in this regard, the opponents approximately correspond to each other, with neither obtaining an advantage.

5) Corrections in initial (muzzle) velocity caused by variations in the condition of the charges (see Fig. 6). These include charge temperature. Within a range of tolerance, accounted for in the Range Tables, a higher temperature would result in a higher initial velocity, and a lower temperature – in a lower velocity. Other factors are not so predictable. The very conditions of storage can negatively affect the charges, and could result in a breakdown of the chemical components, while excess moisture would reduce burning efficiency. In our opinion, the Italians had a slight advantage in this area.

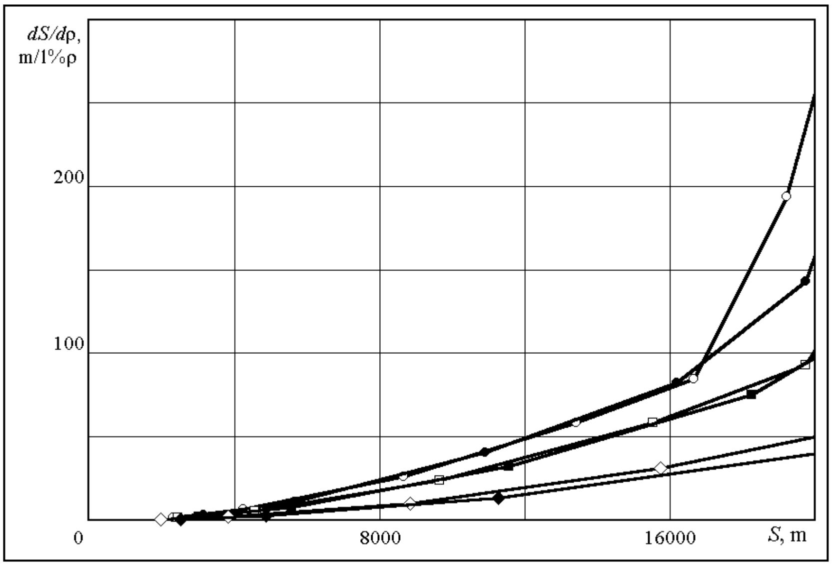

Fig. 5. A correction for air density

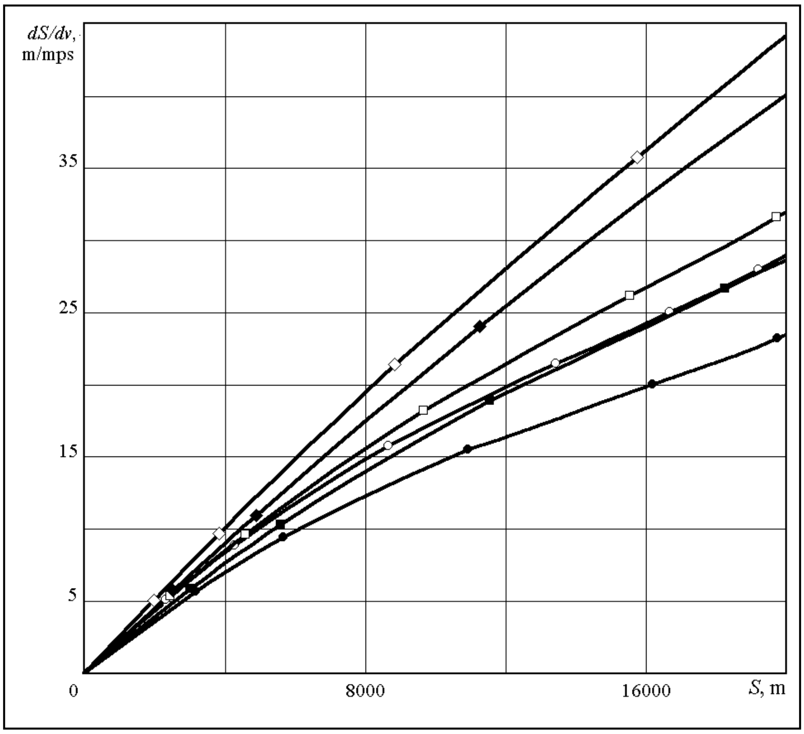

Fig. 6. The correction on initial velocity

On the face of it, the British Royal Navy has an advantage over the Italians in only one area of correction, but it is the most important and significant. What does this mean? In the theoretical sense, the smaller danger space of the lower velocity British guns would imply that only the most careful preparations and calculations would counter the Italian advantage in hit probability. However, the ballistic effects of roll are less for the British than for the Italians, and therefore correspondingly easier to correct. The worse is the sea state, the greater is the British advantage in this respect. It is interesting that, empirically, the Italian gunnery performance should have improved as a result of their reducing the muzzle velocity of their guns. The effect would have been to decrease the danger space, on the one hand, but to enjoy a corresponding decrease in the dispersion caused by the roll of the ship, on the other.

Conclusion

It is interesting to note that both the Royal Navy and the *Regia Marina* came to similar conclusions based on the empirical evidence of combat, and over the course of the war demonstrated an inclination to favor reduced muzzle velocities. Such reductions could be ten per cent or more, giving, for example, the Italian 152-mm cannon a new muzzle velocity of 850 m/s from its original of 1000 m/s.

We are aware of the fact that such measures can only attempt a 'cure for the disease', but in any case do not answer the question of the 'severity of the disease'. The British guns, of course, demonstrated much less sensitivity to roll, but also a marked inferiority in other areas of performance, that they stood to gain little or nothing from further reductions in muzzle velocity.

Thus, the choice of any one or two specifications as a marker for the evolution of a 'cultural community' can give the illusion of progress, but paradoxically lead to misunderstanding of the deep historical processes that affect the synergistic relationship of many parameters (Crawford *et al.* 2005).

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