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Technological maturity for *Jeune École*: The case of Ukraine's naval strategy

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Abstract

This paper conducts an in-depth study on how Ukraine changed the balance of military power in the Black Sea. It conceptualises the idea that the development of modern military technology has reached a level of maturity, providing a new perspective for the Jeune École concept. The paper uses the process tracing method to establish a timeline from Russian full blockade to Ukrainian sea denial. The battlefield application of anti-ship cruise missile (ASCM) in the early stages of the war created the necessary conditions for establishing sea denial, followed by the continued use of ASCM, aerial drones, and maritime drones to consolidate the initial successes. The international community observed Ukraine's deployment of unmanned systems with great interest, heralding it as the dawn of a new era in naval warfare. However, when analysed in depth, it becomes clear that traditional weaponry played the decisive role in achieving sea denial initially. Only after the Russian Federation's fleet had been forced from the coastal waters did naval drones begin to extend and solidify the denied area. The research further indicates that even a smaller state can produce significant strategic effects using anti-ship cruise missiles and swarming maritime drones—principles rooted in the historic Jeune École doctrine. Findings reveal that technological advances have significantly mitigated the traditional limitations of small platforms, especially in adverse conditions. As such, the combination of Jeune École's asymmetric maritime strategy and modern unmanned systems offers a viable blueprint for smaller nations to challenge superior naval forces, dispute blockades, and achieve effective sea denial.

Keywords:

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Introduction

For centuries, having command of the sea has been a condition for a navy to rule the waves. When great discoveries brought the world's riches to Europe, naval build-up was the means to secure the transport of goods and defend overseas colonies (Heuser, 2015). As the steam engine and iron armour became available for naval shipbuilding, France began to fall behind her arch-enemy, the United Kingdom, with respect to the modernisation of her fleet. The United Kingdom could afford to invest more in iron ships with steam engines. Thus, it was imperative for France to develop a new naval strategy to challenge the Royal Navy and its dominance at sea. A new strategy—the *Jeune École* or New School—advocated the use of modern technology, such as torpedoes, on a large number of small and agile ships to overwhelm big and clumsy battleships, thus creating the same effect with less money (Roksund, 2007).

A historical analysis of French naval warfare by Navy Captain Grivel (1869) brought a significant change to naval strategic thinking in France and is considered a precursor of the Jeune École naval strategy (Roksund, 2007). Grivel's (1869) research on the Crimean War (1853–1856) and the Prussian War against Austria (1866) led to the conclusion that commerce raiding would be the most effective way to fight against a superior navy and nation (Roksund, 2007). Admiral Theophile Aube picked up the commerce raiding theory and developed it into the Jeune École naval strategy (Dahl, 2005). This new thinking was also driven by the financial limitations of supporting the construction of large battleships. Thus, commerce raiding was merged with modern technology, like the torpedo, and this laid the groundwork for the theory that a swarm of small ships could attack a sea line of communication and suffocate an adversary, achieving decisive results that could end a war (Canuel, 2018). When the theory was put to the test, Aube discovered that small vessels were not sufficiently sea-worthy to block the United Kingdom and that the precision of the torpedoes and on-board guns was lagging behind their intended task. At that time, Jeune École had not materialised into a working strategy (Dahl, 2005). Technological immaturity and political turmoil in France undermined Aube's vision. Nevertheless, he was right in predicting that such tactics could undermine the superiority of a large fleet and present a credible threat to sea lines of communication (Canuel, 2018).

The world experienced technological innovations that set the stage for a revolution in naval warfare after the French came up with the idea of Jeune École. The birth of Jeune École in the late 19th century was supported by weapons development that promised previously unseen possibilities in the conduct of battles at sea and opportunities for gaining sea power without expensive battleships. This is in parallel with the development of unmanned technology in contemporary warfare.

Jeune École also called for economic war against enemy sea lines of communication, but the theory was premature for its time, as technological progress did not support the strategic and tactical goals of this naval strategy. One of the reasons for the strategy's poor performance was the difficulty faced by the crews of the small vessels, as sailors suffered from sea sickness and could not fight. Today, this obstacle has been addressed—uncrewed systems are being used in contemporary war, and sailors are no longer the weakest link in achieving the strategic and tactical goals of naval warfare. Thus, it appears that the time has come to review the strategic thinking of Jeune École, as technological maturity is presenting smaller navies with opportunities to dispute the superiority of a stronger navy, as demonstrated by Ukraine (Bruns, 2024).

The Russo-Ukrainian war has revitalised a more than 100-year-old theory with the aid of technological innovation as it presented opportunities for a country with practically no

navy to stand against an overwhelming force and dispute the superiority of a large navy in the Black Sea. Ukraine's ability to break the sea control of Russia and achieve sea denial with the help of modern military technology encourages a review of the dominant paradigm of naval warfare regarding the comparability of the military potential of opposing fleets. Sea control is the ability "to use a part of the ocean/sea for one's own purposes and to deny the same to the enemy in time of open hostilities" (Vego, 2016, p. 24), and it is commonly understood that sea control is limited in space, time, and degree (Vego, 2016, pp. 34–35). To achieve sea control, one of the belligerents must engage an adversary's combat elements in all three dimensions, the air, the surface, and the subsurface (Till, 1982, p. 186), or create a naval or economic blockade (Heuser, 2015).

Seemingly, sea control is the prerogative of the stronger navy, able to create significant risk for the other or defending side. Thus, the defending side would prosecute the disputing of sea control or the establishment of sea denial. Sea denial is "the complete or partial denial of the use of an area of the sea to an opponent when friendly forces are not able or do not wish to gain sea control of that area" (Defence, 2014). Similar to sea control limitations of time, space, and degree, sea denial can be established partially or completely in one or more physical mediums (surface, subsurface, and the air) (Vego, 2019). Further, in accordance with Vego (2019), sea denial can only be temporary and limited, or conditional. Sea denial is exercised via major or minor tactical actions using conventional tactics, like the use of coastal defence cruise missiles, naval mining, and submarines, or by asymmetric tactics, like swarm attacks with fast patrol boats or unmanned aerial vehicles (UAVs), unmanned surface vehicles (USVs), and unmanned underwater vehicles (UUVs) (Vego, 2019, p. 119). Thus, offensive spirit is also a prerequisite in the achievement of sea denial (Vego, 2019). In summary, in this paper, sea control refers to conditions where one of the belligerents has the ability to use part of the sea for its own purposes and deny the adversary the use of the same area, but sea denial is associated with conditions where the use of a particular area has been denied to the opponent and there is no ability or intention to establish sea control.

The paper tests the assumption that robotics and autonomous technology combined with artificial intelligence present new naval warfare opportunities similar to the opportunities presented when torpedoes, submarines, and naval mines were used. The Russian invasion of Ukraine presents a field for testing the ideas of Jeune École in contemporary circumstances. The war also directs attention to the notion that navies with financial and personnel limitations can potentially have considerable capabilities at a cheaper price by employing useful strategy in combination with innovative technologies. In the overwhelming shadow of Russian superiority, Ukraine's forces have successfully disputed the Russian Federation (RF) Black Sea Fleet's (BSF) dominance in the western part of the Black Sea using technological advancements and innovation. Hence, this paper seeks to answer two research questions: (1) What caused the transition from Russia's total blockade of the Black Sea in 2022 to the sea denial achieved by Ukraine in 2024? and (2) to what extent does modern military technology support the use of the principles of Jeune École naval strategy in modern warfare? Based on the analysis of the obtained data using the process tracing method, the paper investigates how Ukraine implemented the transition from Russian total blockade to Ukrainian sea denial in the Black Sea following Russia's full-scale attack on Ukraine in 2022.

Method

The paper investigates the causal mechanism between the development of modern military technology that find application in various naval warfare strategies and

the ability of a state with almost no naval power to achieve sea denial against one of the world's most significant naval powers. The process tracing method (Bennet and Checkel, 2015; Collier, 2011) was chosen to achieve the research objectives because the Russo-Ukrainian war in the Black Sea is a typical case for tracing causal mechanisms (Beach and Pedersen, 2016, p. 13) since the outcome (transition from Russian full blockade to Ukrainian sea denial) and the cause (the development and deployment of modern military technology) are present. We used a seven-step model described by Ricks and Liu (2018) to conduct process tracing in the context of the Russo-Ukraine war in the Black Sea. The first step was the formulation of the main and rival hypotheses; the second step was the establishment of the timeline from the initial stage of the cause to the outcome; the third step was the construction of a causal graph illustrating the major turning points in the process until the outcome; the fourth step was the identification of alternative choices or events; the fifth step was the identification of counterfactual outcomes; the sixth step was the identification and evaluation of evidence for the primary hypothesis; and the seventh step was the identification and evaluation of rival hypotheses (Ricks and Liu, 2018).

The facts for the causality research were identified on the websites of international and Ukrainian news agencies and news media (bbc.com; twz.com; blackseanews.com; kyivindependent.com; businessinsider.com; theguardian.com; independent.com; navalnews.com; cnn.com; reuters.com; and news.sky.com). Other sources include the Defence Intelligence of Ukraine (gur.gov.ua), the Ukrainian Navy (navy.mil.gov.ua), online defence and security journals and policy briefs (armyrecognition.com; understandingwar.org; and ispk.uni-kiel.de), naval warfare analytics (blacksealaw.org; cimsec.org; and hisutton.com), and an academic journal (*Small Wars & Insurgencies*). Detailed information about the attacks, including the number of ships, the time, location, target, and outcome, was searched for within the mentioned information sources using the keywords "USV," "naval warfare," "Ukraine," "drone," and "attack." The identified facts were grouped using themes from the variables: the transition from Russian total blockade to Ukrainian sea denial, exploiting advances in innovative military technology, applying the principles of Jeune École naval warfare strategy, applying conventional naval warfare strategies using conventional naval weaponry, and support from its allies. The facts within each variable were arranged afterwards in timelines, allowing us to test hypotheses concerning the major causes of the transition from Russian total blockade to Ukrainian sea denial.

Transition from Russia's total blockade to Ukraine's sea denial in the Black Sea

We defined three hypotheses to answer the research questions about the causes of Ukraine's success in achieving sea denial in the Black Sea and the impact of modern military technology on the use of asymmetric naval warfare principles as developed in the Jeune École naval warfare strategy.

The main hypothesis assumes that Ukraine's ability to achieve sea denial in the Black Sea was determined by its innovative military technology, which was used in accordance with the principles of the Jeune École naval warfare strategy—commerce raiding, asymmetric naval warfare, and the strategy of the weak (Roksund, 2007):

> H1: Ukraine established partial sea denial in the Black Sea by exploiting advances in innovative military technology and applying the principles of Jeune École naval warfare strategy.

The alternative hypothesis also includes the use of innovative military technology as one of the explanatory variables, albeit it was analysed in the context of conventional naval warfare strategies to test the extent to which the Jeune École naval warfare strategy was decisive:

H2: Ukraine established partial sea denial in the Black Sea by exploiting advances in innovative military technology and applying conventional naval warfare strategies using naval warships.

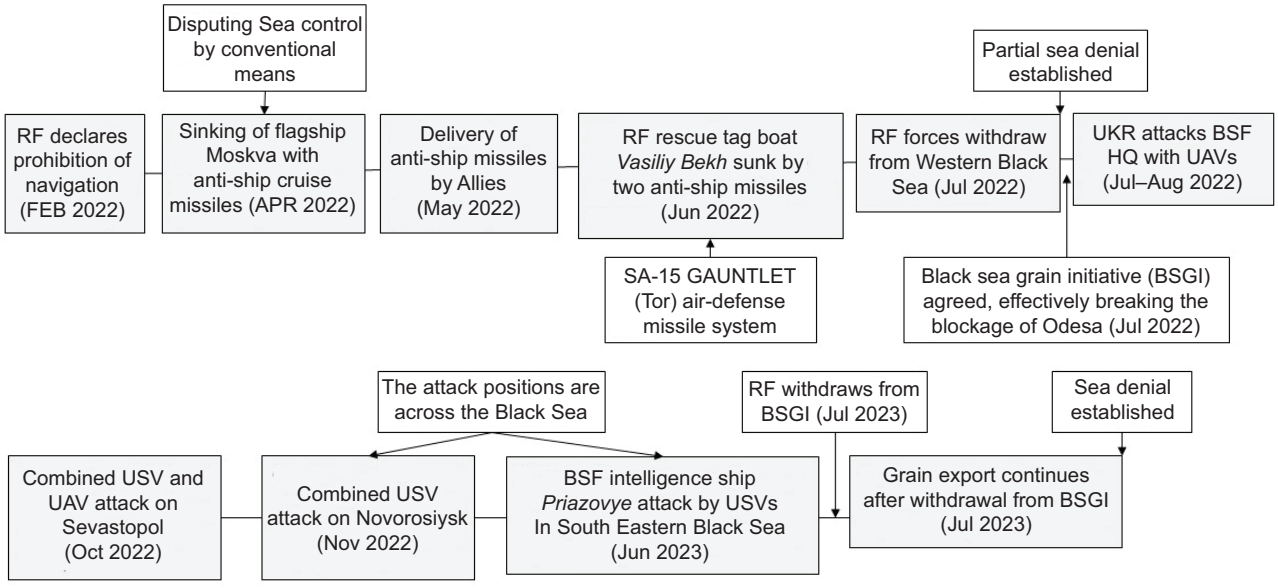
The second alternative hypothesis examines the possibility that the determining causal mechanism lies outside military technology and strategy but is related to support for Ukraine from states with higher military power, including political support, conventional weapons, and intelligence sharing:

H3: Ukraine established partial sea denial in the Black Sea with support from its allies.

Thus, the transition from Russian total blockade to Ukrainian sea denial is the dependent variable in the study, which was analysed in relation to four independent variables: the use of innovative military technology; applying the principles of Jeune École naval warfare strategy; applying conventional naval warfare strategies using anti-ship missiles; and support from its allies. In the process of analysing the empirical data, we created a timeline for each variable, based on which a causal graph of major turning points in the establishment of sea denial was created (Figure 1).

The transition from Russian total blockade to Ukrainian sea denial was marked by several noticeable turning points, especially the use of anti-ship cruise missiles and uncrewed maritime drones (Black Sea Institute [BSI], 2024). When the RF BSF established what they called a navigation prohibition zone (Sutton, 2024) in February 2022, Ukraine's ports were effectively blocked from the sea, and the shipment of goods to and from harbours ceased (Zagorodnyuk, 2022). The RF surface fleet were patrolling the western Black Sea, bombarding land targets, including port facilities and civilian shipping, and conducting amphibious demonstrations off the coast of Odesa (Sutton, 2024). Ukraine changed this behaviour by sinking the cruiser Moskva with a home-developed anti-ship missile

Figure 1. Causal graph of the process from Russian total blockade to Ukrainian partial sea denial.



(BSI, 2024); the targeting process was most likely supported by intelligence from Ukraine's allies (Lendon, 2022). In addition, allies supplied land-based Harpoon and Brimstone missiles to Ukraine (Lendon, 2022), but the RF still disregarded Ukraine's established A2AD (anti-access/area-denial) bubble. Thereafter, Russian rescue tug, supplying military materials to Snake Island, was sunk by a Harpoon missile (Ozberk, 2022a). This loss for the BSF was notable, since the tug was equipped with an air-defence system known as the Tor, considered by the RF armed forces as a state-of-the-art air-defence system, which was supposed to be impregnable to any Western missile system. Following the sinking of the Moskva, the most sophisticated air-defence ship in the BSF, and a tug with a state-of-the-art air-defence system, the BSF withdrew from the western Black Sea (Sutton, 2024). Shortly after, in July 2022, the Black Sea Grain Initiative (BSGI) was signed, partially lifting the blockade (BBC, 2024). Two milestone events followed—Ukraine attacked the BSF HQ in Sevastopol in August 2022, using UAVs (Bruns, 2024) and, more significantly, conducted a combined USV and UAV attack on the same HQ on 29 October 2022 (Sutton, 2022). If the western Black Sea was needed by Ukraine to re-establish the use of sea lines of communication, then it was necessary to deny the RF the use of the remaining part of the Black Sea by long-range strikes on targets of opportunity. This was achieved by attacks on Novorossiysk Harbour (Kharuk, 2024) and ships across the maritime theatre on several occasions, which are marked in the causal graph (Pili, 2024). The success of these attacks was largely based on the support of allies through the sharing of intelligence concerning the targeting process (Detsch, *et al.*, 2025); thus, allies might have played an important role in disputing RF sea control.

As was expected, the RF withdrew from the BSGI in July 2023. However, grain shipments continued after the break-up of the BSGI, although the volume reduced by several million tons for a few months (BBC, 2024). The shipments reached the pre-war volume by February 2024 (BBC, 2024). This should be considered as an established sea denial in the western Black sea.

With regard to the assessment of alternative choices or events (step four in the process tracing) concerning Ukraine's maritime domain, it should be noted that if Ukraine had not been able to achieve sea denial in the western Black sea, a number of outcomes would have been inevitable. Firstly, grain exports would have halted after the RF withdrew from the BSGI. This would have had major consequences on the grain market, as Ukraine is one of the largest exporters of various grains. It would also have had a major impact on Ukraine's ability to continue its war against Russian aggression, as revenues from grain exports support its war efforts. Secondly, the RF BSF would be able to operate in littoral areas close to Ukraine, which would draw Ukrainian forces to the coastal areas for coastal defence. This would have an impact on the war in the rest of Ukraine, as the recruitment of fresh forces is somewhat challenging in Ukraine (Malenko, 2025). Thirdly, this moral boost early in the war had an unprecedented effect on the fighting spirit of the whole nation as well as on the naval forces. The loss of a large number of ships left the Ukrainian navy with coastal defence units and an air wing, but Ukraine's ability to interdict the surface fleet boosted the navy's role in its overall resistance to the aggressor.

Hypothetically, if Ukraine had been unable to use innovative technology, some counterfactual outcomes could have been identified. If innovative technology had not been used and if conventional weapons had been the only means of disputing sea control, the RF would not have withdrawn from the western part of the Black Sea, and the grain corridor would have been under threat from the surface fleet.

If Turkey had not closed the Bosporus Strait, the RF would have reinforced the BSF with other capable combatants, and the operational calculus of the RF would not have

changed. The commerce raiding and asymmetric warfare would have been harder to execute, and the RF would have had another air-defence ship to protect the harbour and other critical infrastructure. The complexity of allied assistance is difficult to assess at this point, as only few details have been revealed to the public regarding allied help during the early stages of the battle for the Black Sea.

The hypotheses were tested using the methodology described by Bennett and Checkel (2015) and Collier (2011). The suggested tests for the process tracing method are the "straw-in-the-wind," "hoop," "smoking gun," and "double decisive" tests, which prove hypotheses based on two criteria: the sufficiency and the necessity of the evidence obtained. The straw-in-the-wind test is passed if the evidence is neither sufficient nor necessary; the hoop test is positive if only necessary evidence is obtained; the smoking-gun test is passed if only sufficient evidence is obtained, while the double decisive test is passed if the evidence is both necessary and sufficient (Collier, 2011).

The main hypothesis passes the straw-in-the-wind, hoop, and smoking gun tests but fails the double decisive test. The use of innovative technology and the principles of Jeune École for establishing sea denial was not initially a decisive prerequisite in the battle for the Black Sea. The anti-ship cruise missile (ASCM) established the A2AD zone in the western Black Sea, followed by the application of USVs later in 2022. The use of innovative technology and tactics began on 29 October 2022; a major combined Ukrainian USV and UAV attack on Sevastopol was carried out by Ukrainian forces a few months after the RF withdrew from the western Black Sea. During the first use of combat surface drones, several USVs penetrated the harbour, and two warships, namely the mine sweeper Ivan Golubets and the frigate Admiral Makarov, were hit by Mykola USVs, but neither of the ships sank.

Nevertheless, Russia withdrew its fleet into its bases and increased harbour defences, thus indicating the achievement of tactical and operational successes by Ukraine. In addition, Ukraine conducted attacks on Russian Black Sea harbours in Sevastopol (October 2022) and Novorossiysk (18 November 2022), on oil production facilities in Tuapse (February 2023), and on surface ships across the Black Sea (March and June 2023). Due to the lack of a surface fleet, Ukraine has resorted tousing all possible means to attack RF BSF harbours and bases, inflicting damage by using small, agile uncrewed craft for surface and air attacks. This is an indication of the use of innovative technology and the principles of Jeune École in naval warfare. The impact of the above strategy is the extension and consolidation of the denied area. Nevertheless, the strategy was not a decisive piece of evidence in itself, as Russia has found ways to counter drone threats by using helicopters and maritime drones, fast jet skis, and self-protection measures. Ukraine used innovative technology in asymmetric attacks and commerce raiding after it had pushed Russia's surface fleet beyond the ASCM A2AD bubble.

The second hypothesis passes the double-decisive test, as the battlefield application of ASCM in the early stages of the war created the necessary conditions for establishing sea denial, followed by the continued use of ASCM, UAVs, and USVs to sustain the denial of the Black Sea to the RF surface fleet. As a result of applying conventional weapons and innovative technology, Ukraine regained control of Snake Island, expanded its sea denial area, and resumed grain exports from Odesa Harbour via sea lines of communication. Ukraine used conventional weapons—ballistic and cruise missiles—in March and April 2022. In this regard, on 24 March 2022, Ukraine managed to attack the RF BSF's landing ship in the harbour of Berdyansk (Sutton, 2022), and on 13 April 2022, it sank the RF BSF's flagship, Moskva, using a Ukraine-produced Neptune anti-ship missile (Bruns, 2024) and probably intelligence from allies. The sinking of the cruiser Moskva

with Neptune anti-ship cruise missiles (ASCM) was a triple victory—Ukraine removed air-defence from the southern flank of the RF's maritime forces, boosted the morale of its forces, and demonstrated its ability to build and use ASCMs, thereby changing the strategic calculus of the RF BSF (Clark *et al.*, 2022). This event marked the first milestone (Figure 1) for Ukraine in a series of events aimed at creating sea denial in the northern Black Sea, as it demonstrated Ukraine's ability to protect its coastline with a layered defence capability. Later the same year, on 17 June, another Russian ship was sunk by an anti-ship missile (Ozberk, 2022b), the second of such ship to be hit by a missile from the coast defence battery. The sinking of the BSF surface vessels was a decisive shock to the BSF, and following these events, the BSF command withdrew its surface fleet in June 2022 from the western Black Sea (Sutton, 2024). Thus, the use of anti-ship missiles in the early stage of the conflict broke the Russian blockade of Odesa and pushed its surface fleet out of the western Black Sea. Later that year, on 29 October 2022, a major combined Ukrainian USV and UAV attack on Sevastopol was carried out by Ukrainian forces. As a result, Russia withdrew its fleet to its bases and initiated increased defence. Thus, Ukraine achieved tactical and operational successes, demonstrating its ability to deny its adversary access to the Western maritime theatre.

In addition, Ukraine conducted attacks on BSF harbours in Sevastopol (October 2022) and Novorossiysk (18 November 2022), on oil production facilities in Tuapse (February 2023) as well as on surface ships across the Black Sea (March and June 2023). Thus, early in the conflict (March–June 2022), Ukraine disputed the RF BSF's established blockade and thereby established sea denial with conventional weapons—ballistic and anti-ship cruise missiles. Later the same year and the following year, Ukraine expanded the area denied to the BSF fleet by utilising innovative technology—uncrewed surface vehicles.

The third hypothesis passes the straw-in-the-wind and smoking gun tests but fails the double decisive test. Turkey provided the first assistance to Ukraine from the allies at the start of hostilities, namely the closure of the Bosporus Strait. Even though the RF had managed to complete its build-up of naval forces, it was a significant blow to the RF and demonstrated the weakness of the RF's scattered naval basing across four RF fleets (Myers, 2022). The closure of the Bosporus Strait prohibited the reinforcement of the BSF. In May, the allies supplied Harpoon and Brimstone missiles to Ukraine, and Ukraine could then threaten surface ships and off-shore installations in the western Black Sea (Sutton, 2024). Following the supply of the mentioned missiles, the BSF withdrew from the northern Black Sea, which "is a significant change in balance" (Sutton, 2024). In summary, assistance from an ally through the closure of the Bosporus Strait prevented the RF from reinforcing the BSF but did not have a direct effect on the establishment of sea denial. The supply of anti-ship missiles had a direct impact on establishing sea denial. Currently, the support from allies in the form of USV technologies has not been disclosed to the public, although there are strong indications that allies might have provided necessary parts for the development of maritime drones, thus contributing to the establishment of sea denial. This hypothesis would need revision after sufficient information is made available by Ukraine or the allies in question.

Conclusions

The international community observed Ukraine's deployment of maritime and aerial drones with great interest, heralding it as the dawn of a new era in naval warfare. However, when analysed in depth, it becomes clear that initially traditional weaponry played the decisive role in achieving sea denial. Only after the RF's fleet had been forced from the coastal waters did naval drones begin to extend and solidify the denied area.

Research further indicates that even a smaller navy can produce significant strategic effects using anti-ship cruise missiles and swarming maritime drones—principles rooted in the historic Jeune École doctrine. Ukraine effectively challenged Russian sea control across the entire Black Sea through the innovative use of domestically developed technology. Ukraine expanded its operational reach by deploying drone swarms to target naval vessels, commercial ships, bases, and port infrastructure.

With vital intelligence and likely technological support from its allies, Ukraine successfully disrupted the economic blockade initially imposed by the Russian surface fleet, enabling the reopening of port facilities and the resumption of grain exports. Findings reveal that technological advances have significantly mitigated the traditional limitations of small platforms, especially in adverse conditions. As such, the combination of the asymmetric maritime strategy of Jeune École and modern unmanned systems offers a viable blueprint for smaller navies to challenge superior naval forces, dispute blockades, and achieve effective sea denial.

Although guided missiles and conventional warships will remain central to naval power projection, the resurgence of this century-old strategy—revitalised by cutting-edge technology—signals a meaningful shift in the dynamics of maritime warfare. The Jeune École strategy deserves a re-birth in naval strategy discussion as a plausible way for smaller navies to counter overwhelming force.

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Author Contributions

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Data Availability Statement

Not applicable.

Disclosure Statement

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