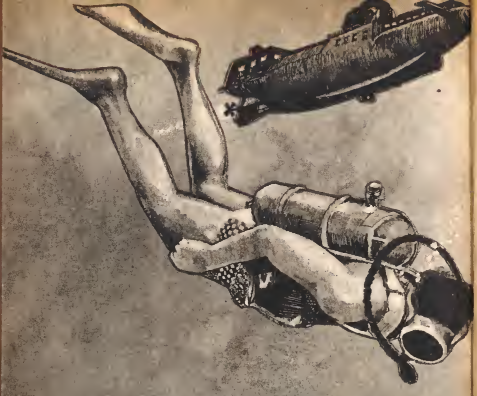
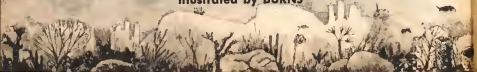


THE WATERY WONDERS OF CAPTAIN NEMO

By THEODORE L. THOMAS

This isn't fiction.
It concerns the legends all of us have heard about
the uncanny predictions of J. Verne, Esq.
Most of them are!

Illustrated by BURNS



JULES VERNE'S *20,000 Leagues under the Sea* was published in 1869. Since then we have heard a great deal about the excellence of the science, speculation and prediction it contains. People seem to feel that Verne's sound scientific speculation makes the novel good science fiction, even though they may not care much for it as a straight story.

But these days the waters are full of SCUBA divers. (The word "SCUBA," as most people are beginning to know, is made by taking the first letter in each word of the phrase "Self-Contained Underwater Breathing Apparatus.") SCUBA divers carry their own air down into water as deep as three hundred feet in lakes, oceans, streams, rivers, bays, quarries and caves all over the world. There is a rash of books on the subject, and many SCUBA divers are fairly well-versed in the history of man's descent beneath the water. When a SCUBA diver takes a critical look at *20,000 Leagues under the Sea*, a new interpretation of the novel emerges.

The novel isn't at all what literary critics have said it is.

The diving gear and the diving scenes are technically pretty bad, behind the times even for 1869. The submarine *Nautilus* itself is out of date for 1869, with the sole exception that electricity is the source of power. In none of these technical situation did Verne take advantage of knowledge readily available to him at the time. It is as if he sat in his chair and dashed off his concepts without bothering to get up and check facts that must have been in books in the same room with him. He spun his yarn from the material in his head. And there you have a clue to the real value of the novel.

Verne was a mighty story-teller. His science was bad, his speculation absurd, and even his plot and his characters might be poor. No matter. Put them all together with the magic of Verne's story-telling ability, and something flames up. A story emerges that sweeps incredulity before it.

IT is a very difficult thing to read this novel in a hostile frame of mind, looking for the blunders, noting all the scientific misinformation. For one thing, Verne uses a nifty device for presenting much of the so-called scientific data in the novel. He will have one of the characters, say the narrator, Professor Aronnax, poised on the brink of some exciting event, and then he will ladle in the scientific nonsense. In this posture of the story, who stops to think about science? Verne can get away with almost anything, and he does.

The power of Verne's storytelling ability shows up in another odd way. After reading the novel, people remember things from it that are not there. The impression that the novel contains valid scientific prediction seems to grow as the years roll by. Recently, a United States Patent Office official received an interesting inquiry. Was it true that a patent examiner had rejected the patent application of an inventor of a new periscope because of the periscope described by Jules Verne in *20,000 Leagues under the Sea?* Well, the fact is that Verne is totally silent on the subject of periscopes in the novel. The *Nautilus* had no periscope.

Another mis-remembered description concerns the storage batteries used aboard the *Nautilus.* There are none. The only time Verne specifically mentions a battery is in connection with diving dress; Captain Nemo says the battery makes electricity out of sodium instead of the usual bichromate of potash. The novel leaves readers with the impression that it is a storehouse of advanced technology, and the impression grows as the reader ages. (It would be interesting to find out how many adults reread it after having read it in their teens. Libraries tend to carry it in the section for younger readers.)

Probably the best parts of the novel are those which describe the activities of the characters as they roam on the bottom of the sea in their SCUBA gear. Verne was not concerned with many of the dangers guarded against by modern SCUBA divers, things like air embolism, nitrogen narcosis and the bends. That's all right. Diving was not sufficiently far advanced for these things to be of concern. It wasn't until the 1870s that the Frenchman Paul Bert completed the 1660 work of the Englishman Robert Boyle. Bert put out a book on diving physiology describing how nitrogen can bubble out of a diver's blood when the diver comes up too fast. Bert was the man who pointed out the ways to avoid the bends. The diver could recompress in a chamber at the surface in order to relieve the pressure slowly and at will, or the diver could come up slowly and in stages. Both of these systems allowed the excess nitrogen in the blood to be thrown off in the exhaled air. Verne could not possibly know about such things, and the lack of discussion of such diving dangers in the novel cannot be held against him.

THE SCUBA used by Captain Nemo and his crew has long been held up as a good example of Verne's ability to forecast scientifically. Even Verne himself in his later years forgot that Captain

Nemo says, when he first describes the diving apparatus to Professor Aronnax, "It is to use the Rouquayrol apparatus, invented by two of your own countrymen, which I have brought to perfection for my own use." The two "countrymen" are Rouquayrol, a mining engineer, and Denayrouze, a Navy officer. Their SCUBA gear was in use in 1865, four years before Verne published his novel. In the actual gear, an air hose ran from a compressor on the surface down to a tank carried on the driver's back. A second hose ran from the tank to a mouthpiece through which the diver breathed. Some kind of valve on the tank fed the compressed air to the mouthpiece at a pressure about equal to the pressure of the water at that depth. Once the diver's tank was charged, the diver could unplug the hose that ran to the surface and freely walk around a bit using the air in his tank. He could then return to the hose and plug in again for another charge of air.

Apparently Verne had heard about the gear, although toward the end of his life he insisted he had dreamed about it. For use in the novel, he made some changes in the gear without bothering to check the gear itself, or even to think much about it. For one thing, Captain Nemo says, "I, in encountering great pressures at the bottom of the sea, was obliged to shut my head, like that of a diver, in a ball of copper." This was nothing new, either. The closed-helmet diving dress had been in steady use since its invention by Augustus Siebe in 1840 . . . a diving dress so good that nothing more than refinements have been added to it to this very day. Verne adds an innovation to the helmet in the novel. "In the Rouquayrol apparatus such as we use, two india-rubber pipes leave this box and join a sort of tent which holds the nose and mouth; one is to introduce fresh air, and the other to let out the foul, and the tongue closes one or the other according to the wants of the respirator."

Apparently Verne was not aware of the existence of check valves, so he requires that the diver use his tongue to control the incoming and outgoing air. Yet check valves were in use in the Siebe diving helmet 29 years earlier, in 1840. Verne simply did not bother to get out of his chair and check. On top of that, he forgets that his SCUBA gear has no check valves. On that first walk on the bottom of the sea, Professor Aronnax, Captain Nemo, Conseil and one of the crew were out under the water for a total of ten hours. Toward the end of that walk they all get sleepy and take a little nap. Things have been happening so fast and furiously that both Verne and the reader alike forget that Verne's SCUBA gear demands that the tongue alternately pop into and out of the two breathing tubes, a good trick when one is asleep.

THEN there is the matter of air consumption. The modern SCUBA diver exhausts each breath into the water, except in the rarely-used rebreather types of diving gear. Verne properly saw that air does not last very long when you breathe it once and blow it out into the water, so he said that his divers would breathe the same air over and over. Each diver would carry a tank of air charged by "the pumps of the *Nautilus*" to a pressure of "fifty atmospheres." The 71.2 cubic foot tank of a modern SCUBA diver is charged to a pressure of 153 atmospheres, and most of us run in a little more. Such a charge will last for 25 minutes at a depth of 100 feet. Verne needed to keep his divers going for ten hours.

Early in the novel Professor Aronnax points out that a man "consumes, in one hour, the oxygen contained in more than 176 pints of air, and this air, charged (as then) with a nearly equal quantity of carbonic acid, becomes unbreathable." (The French version of the novel states the quantity of air as 100 liters; this accounts for the odd precision of the equivalent in British pints.)

In ten hours, Verne's divers would each need 1760 pints of air. This converts into 0.71 cubic feet of air at the specified 50 atmospheres, assuming air to be a perfect gas, and is a nice convenient quantity to carry on one's back. It weighs about 2.59 pounds, and it contains only about 0.54 pounds of oxygen. Professor Aronnax also says about the air they will breathe during the dive, "when it only contains fifteen per cent of oxygen, it is no longer fit to breathe." This leaves a total of 0.15 pounds of consumable oxygen for each man for a ten-hour period, about one-tenth the oxygen needed by a 150-pound man engaged in very mild exercise at atmospheric pressure. This man would also generate 1.25 pounds of carbon dioxide in a ten-hour period, producing with the 1760 pints of air an atmosphere containing about 48.3 per cent carbon dioxide. This would swiftly kill him.

If the 0.54 pounds of oxygen available in the tank were converted to carbon dioxide, the diver's atmosphere would still contain 20.8 per cent carbon dioxide, enough to kill quickly. A carbon dioxide concentration of 6 per cent causes distress, and 10 per cent produces unconsciousness.

There are other interesting details about the breathing arrangements of Verne's divers. Exhaled air goes back into the portable tank on the diver's back so it can be used again. But the tank is stated to be maintained at a pressure of 50 atmospheres. We are not told how a human being could possibly exhale into a chamber maintained at such a high pressure. In any case, one passage of air through human lungs reduces the oxygen content to about 15 per cent, at which point Verne says, pretty correctly, it is no longer fit to breathe.

VERNE frequently mentions water pressure throughout the novel. If you look for it, it becomes apparent that Verne has no clear idea of the effects of water pressure on immersed objects, or even how diving gear of any kind works. The diving dress for his divers is "made of india-rubber without seam, and constructed expressly to resist considerable pressure. One would have thought it a suit of armor, both supple and resisting." Verne therefore does not know that the air pressure inside the suit balances the water pressure outside the suit, and that the suit does not have to resist "considerable pressure" at all. In fact, the suit is quite flexible, which Verne realizes in a vague sort of way. Not understanding this principle of the balancing of pressures, he feels compelled to offer some explanation of how a diver can exist under great water pressure in a flexible suit. So he talks about the suit's "resisting."

In one scene Professor Aronnax is looking out the great window in the saloon of the *Nautilus*. The *Nautilus* is deep, and the Professor sees a sunken ship suspended in mid-water. It had sunk to a depth where its density equaled the water density, and there it hung, according to Verne. The good Professor says, "we often saw the hulls of shipwrecked vessels that were rotting in the depths, and, deeper down, cannons, bullets, anchors, chains and a thousand other iron materials eaten up by rust." What he means is, heavier objects come to rest suspended in water at depths deeper than light objects. Verne believes that sinking objects all seek their own levels in the depths, each according to its density, and there they hover.

As a matter of fact, water is incompressible for all practical purposes; its density does not change much in the oceans. At the deepest parts of the oceans, at depths of some 36,000 feet—almost 1,100 atmospheres—the enormous pressure increases the density only by some six per cent. Verne's false idea of the effect of the depth on the density of water shows up in the novel every so often. At one point Professor Aronnax notes that the trans-Atlantic cable rests on the bottom in deep water "without anchorage". Whenever the *Nautilus* is to make an unusually deep dive, "the screw set to work at its maximum speed" in order to drive the *Nautilus* down into that "dense" water. Once down, all the *Nautilus* has to do to reach the surface again is to shut off its screw and tip its vanes upwards. It shoots to the surface, squeezed up like a slug of toothpaste from a toothpaste tube. In describing the strength of any animals living in water strata miles beneath the surface, Professor Aronnax says, "it requires incalculable strength to keep one's self in these strata and resist their pressure." Scientists knew better in those days.

The *Nautilus* itself, as a submarine, does not represent anything new in the submarine art, with the exception of the idea of using electricity for power. Captain Nemo says that he extracts sodium from sea water and makes electricity out of it. Everything aboard is run by electricity. But even this speculation is not significant, since the work of men like Volta, Ampere, Cavendish, Henry, Joule, Ohm, Davy, Coulomb, Faraday, Watt and others was completed years before 1869. An American inventor, Thomas Davenport, patented the first electric motor. He ran a railroad car with it in 1839. So the use of electricity aboard the *Nautilus* did not call for the exercise of the imagination.

VERNE'S *Nautilus* was named after Robert Fulton's *Nautilus*, built in 1800 in France, and it was more than named after it. Fulton's *Nautilus* had an observation dome protruding from the upper deck, just like the one on Verne's *Nautilus* 69 years later. In 1855 a German named Wilhelm Bauer launched a submarine fifty-seven feet long. It was named the *Sea Devil*, and it carried a crew of thirteen. It was built to dive to 150 feet, and it had an oxygen-regenerating system, an observation dome at the bow, and an air lock so that a diver could enter and leave under water. All this was fourteen years before Verne's *Nautilus*. Once a day it was necessary for Verne's *Nautilus* to surface to replenish her air. She carried pressure tanks for air storage, but no air-regenerating system.

Early in the novel Captain Nemo takes Professor Aronnax on a tour of the *Nautilus*. At the end of this tour the reader supposes he has learned something about how the *Nautilus* operates. This isn't true. We learn, "This engine room, clearly lighted, did not measure less than sixty-five feet in length. It was divided into two parts; the first contained the materials for producing electricity, and the second the machinery that connected it with the screw." Then Captain Nemo tells us, "I use Bunsen's contributions, not Ruhmkorff's. Bunsen's are fewer in number, but strong and large, which experience proves to be best. The electricity produced passes forward, where it works by electro-magnets of great size, on a system of levers and cogwheels that transmit the movement to the axle of the screw." And we never again hear anything about the front part of the room where the electricity is produced. In fact, the only feature we learn about the back room is that the system of levers and cogwheels turns the screw a hundred and twenty revolutions in a *second*, which gives the *Nautilus* a speed of fifty miles per hour—as you might well imagine. This "Bunsen and Ruhmkorff" business seems to be thrown in for the distinction gained from the use of a couple of shining scientific names. Bunsen, among many other things, invented an electric cell that used plates of gas coke instead of platinum, but Captain Nemo does not seem to be talking about batteries here. Ruhmkorff invented an induction coil in 1851.

Anyhow, this is all we find out about the mechanism that drives this most famous of submarines. It isn't much. Yet, thinking back to the description after the lapse of a few years, it seems rosily complete.

WHEN the tour is over, Captain Nemo and Professor Aronnax sit down in the saloon while the captain describes more details of the *Nautilus's* construction. Most of these involve dimensions of the ship. It is here that we learn the secret of the enormous strength of the *Nautilus's* hull, a strength that allows the vessel to dive to depths of several miles once it gets up enough power. The hull is double. "Indeed, owing to this cellular arrangement it resists like a block, as if it were solid. Its side cannot yield; it coheres spontaneously, and not by the closeness of its rivets; and the homogeneity of its construction, due to the perfect union of the materials, enables it to defy the roughest seas." So, for those reasons, the double hull accounts for the great strength of the *Nautilus* . . . apparently on the theory that if one shell is good, two must be better.

Captain Nemo continues to give figures, physical dimensions and properties of materials, which again seem to impart something scientific. Here there occurs the remark, "steel plates, whose density is from .7 to .8 that of water." One translation has ".07 to .08 that of water." A non-technical reader might see nothing wrong, and even a technical reader might slip over the grossly understated density of steel. Verne doesn't really mean it, either; he is not giving us a science-fiction description of lighter-than-water steel. In these paragraphs he also states the weight and dimension of the outer shell, so it is pretty easy to calculate the density of his steel for ourselves.

It works out to be the normal heavy steel we are used to, and not the light stuff he says it is.

While discussing the strength of the hull, Captain Nemo mentions that at a depth of 1,000 feet of water, the walls of the *Nautilus* bear a pressure of 100 atmospheres. But, as every SCUBA diver knows, water pressure increases an additional atmosphere for every 33 feet of depth, not every 10 feet. So at 1,000 feet of water the pressure on the hull of the *Nautilus* would be a total of 31.3 atmospheres, not 100. This same sort of mistake occurs during that first walk on the bottom of the ocean. Professor Aronnax tells us, "We were at a depth of a hundred and five yards and twenty inches, undergoing a pressure of six atmospheres." But this depth of 316 feet produces a total pressure of 10.6 atmospheres.

In this instance Verne thinks every 53 feet of depth produces an additional atmosphere of water pressure, while previously he thought every 10 feet did so. Yet in the opening pages of the novel Professor Aronnax explains to Ned Land, "the pressure of the atmosphere is represented by the weight of a column of water thirty-two feet high." This is just about right; Verne has the correct datum, but he doesn't bother to use it later.

The book frequently reports popular fallacy as if it were scientific fact. For instance, Professor Aronnax muses that the huge mass of wooden material, including wrecked ships, floating in the central point of the Sargasso Sea "will become petrified by the action of the water, and will then form inexhaustable coal mines." A clue as to why such nonsense should be in the novel can be found about halfway through. Professor Aronnax knocks on the door of Captain Nemo's room. He is invited in. He enters and "found Captain Nemo deep in algebraic calculations of *x* and other quantities." Now, nobody with even a smattering of mathematics would put it that way. People don't sit around calculating "*x* and other quantities" as an end in itself. Such a remark could only be made by a man with no mathematical background whatsoever. Verne trained as a lawyer, and then for awhile he thought about going into the banking business. Any knowledge of science he had must have rubbed off on him, and very thinly at that.

WE have been talking about Verne's physical science. There is good reason to suspect that his biological science is just as bad. It doesn't have the right flavor. The crew of the *Nautilus* throw out a net, say in the Indian Ocean, and haul it back loaded. Professor Aronnax looks in the net and says something like, "I saw in the net . . ." and there will follow a listing of the sea creatures in the net, anywhere from one paragraph to three pages long. It is as if Verne pulled toward him a text on marine biology, turned to the listing "Flora and Fauna of the Indian Ocean."

This sort of thing goes on frequently in various bodies of water. Verne has his man look in the net and rattle off what he sees there. Sometimes, as a variation, Professor Aronnax stands at the window while the *Nautilus* cruises beneath the surface, and calls off the contents of the sea they are passing through.

All through the novel occur remarks that show a lack of information on a particular subject—information, that is, which could have been obtained easily enough by asking or looking. One mile visibility under water. Good natural light at 150 fathoms. 7,000 fathom depth of water in the Indian Ocean. It goes on and on.

It is time to emphasize again that Verne is a great story-teller despite his scientific and speculative nonsense. The novel is sprinkled with arresting thoughts. Professor Aronnax wonders if some day there will be cities at the bottom of the oceans, cities that rise to the surface once a day to replenish their air as the *Nautilus* does. Later on, in a conversation between Captain Nemo and Professor Aronnax, they discuss the possibility of excavating the portion of the bottom of the Red Sea where the Pharaoh's army perished while pursuing Moses and the Israelites; such an excavation ought to "bring to light a large number of arms and instruments of Egyptian origin." What a lovely concept!

As a novel, *20,000 Leagues Under the Sea* is a good story. But there is not a single bit of valid speculation in it; none of its predictions has come true. The purported science in it is not semi-science or even pseudo-science. It is non-science.

— THEODORE L. THOMAS