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Exploring Our Little Corner of the World with the Galiano Naturalists

by Richard Pitschka

About 15 years ago I learned to give BC tides the attention and respect they deserve. Four of us had traveled to Telegraph Cove on Vancouver Island to spend a week exploring the area by kayak. On our first day out, we spotted a camping place that looked perfect. Feeling lucky to have found such a beautiful spot, we dragged our kayaks about 50 feet up the sand and cobble beach and set up our tents in a small clearing sheltered by cedars.

The next morning we discovered we were even luckier than we had imagined because when we looked out at the beach, we saw that our kayaks were at least half a kilometer from the water's edge. We were all from central California where the day's highest tide is only about six feet higher than the day's lowest tide in the summer. Never in our wildest dreams had we imagined that the water's edge could advance or recede so mightily. If we had arrived when the tide was not near high water, we never would have guessed how far up the beach we needed to carry our boats in order to keep them from floating away.

During the next six days we consulted our tide table religiously, but paradoxically the more familiar I became with it, the more mysterious it appeared. How was it possible to predict the tides years in advance so accurately? I knew from elementary school science that the tides were caused by the gravitational attraction of the sun and the moon, but that simple idea wasn't sufficient to explain the complexity and precision of the tables we were using.

Over the years since then, I've learned that the ideas involved in predicting the tides are intricate, but quite understandable.

First of all, the basic pattern of the tides can be learned just by watching the shoreline closely on a regular basis. The pattern can be different in different parts of the world due to local conditions, but on Galiano Island, a persistent observer will see that usually there are two high tides and two low tides in a 24-hour period. One of the high tides is often noticeably higher than the other; one of the low tides, noticeably lower.

If you consider the time of a particular tide (say the higher high tide), you will see that the same tide occurs the next day about an hour later. You will also see that any particular tide will seldom be exactly the same level from day to day, but will never vary by more than a foot or so from the day before.

By paying attention to the moon as you observe the tides, you will see that the highest and lowest tides will occur about when the moon is new and when it is about full. You will also discover that the high tides occur every day when the moon is near its highest point in the sky and also about 12 hours later. If you observe carefully for several years, you will find that the highest of the high tides and the lowest of the low tides usually occur around the beginning of the year.

All of this has been known for thousands of years by people making their living along the seashores of the world. It was known by the First Nations people who were gathering shellfish from the shores of Galiano a thousand years before Rome was founded.

But until Sir Isaac Newton published his *Equilibrium Theory of Tides* in 1687, no one anywhere in the world had a scientifically correct notion of why tides happen.

The moon's gravitation, he said, pulls water on the earth horizontally towards the point where its force is strongest. This causes water on the part of the earth most directly under the moon to mound up. As the earth spins, different parts of the earth move into and away from this tidal bulge, which is one of the two high tides that we experience every day. High tide occurs about when the moon appears highest in the sky because that is when our part of the earth is most directly below the moon.

But what about the other high tide--the bulge that arrives about 12 hours later? This second high tide is understood when you realize that the moon doesn't just go around the earth, but that both the earth and the moon revolve around their common center of mass. They are something like a big skater holding the hands of and spinning around with a little skater. Each skater not only feels the tug of the other, but also the centrifugal force pulling them apart. Centrifugal force produced as the earth revolves about its common center of mass with the moon produces the tidal bulge on the side of the earth farthest from the moon.

So there you have it--two high tides every day caused by gravitational and centrifugal forces, and in between, low tides caused by the withdrawal of the water that flowed horizontally to form the tidal bulges.

Because the moon orbits the earth in the same direction as the earth spins, in the 24 hours it takes for the earth to spin once with respect to the sun, the moon has advanced a bit in its orbit around the earth. About 50 minutes are required for a point on the surface of the earth to catch up with the moon. This is why the tidal bulge under the moon arrives every day about 50 minutes later than on the previous day.

If this were the whole story, we would experience a succession of high and low tides of the same magnitude at regular intervals day after day. This is not what we see, and the reason is that there are about a dozen other factors that measurably affect the tides. Among the more important is the gravitation of the sun.

The earth and sun are also locked in a gravitational embrace. In this case, however, the earth plays the role of the smaller skater. The sun being huge in comparison to the moon, its gravity is much, much greater, but it is also much farther away. As a consequence, the moon exerts a pull on the earth's water about two and a half times greater than does the sun.

Like the moon, the sun generates two tidal bulges. These are smaller since the moon's gravity is felt more strongly by the earth, and from our perspective, they look more like modifications of the moon's tidal bulges than like separate bulges. Around the times of new and full moons, the earth, sun and moon are situated more or less along a straight line. At such times, the high tides are bigger because the tidal bulges of the sun and the moon reinforce each other. When the earth, sun and moon are not closely aligned, the combined gravitational and centrifugal forces pull in different directions and the high tides are lower, the low tides higher.

But this is not the whole story either. Every lunar month, the distance between the earth and the moon varies from about 125,000 to about 155,000 miles. When the moon is closer, the earth feels its gravitational pull more strongly, and both high and low tides are more pronounced.

Another factor is that the moon's orbit is a little askew with respect to the earth's equator. During the period from one full moon to the next, every 29.53 days, the moon's path around the earth takes it from about five degrees above the earth's equator to about five below. When the moon is either farthest north or south in its orbit around the earth, the inequality between the two high tides tends to be greatest. This is also true for the two low tides. When the moon's path leads it above the earth's equator, the high and low tides tend to be more equal.

The sun affects the tides in similar ways. The sun's distance from the earth around the second of January is about 3 million miles closer than it is at the beginning of July, which means the gravitational attraction of the sun on the earth is stronger in January. Unusually strong tidal effects can occur around the beginning of the year, especially when the moon's closest approach to the earth coincides with the full moon or the new moon. At such times the gravitational effects of both the sun and the moon are at their strongest and act in support of each other.

And because the earth is tipped on its axis 23.5 degrees with respect to its orbit around the sun, the point of the sun's strongest gravitational effect moves from 23.5 degrees north of the equator in our summer to an equal distance below in our winter. This movement of the point of the sun's strongest effect north and south of the equator has an influence on our tides similar to that of the moon when it is farthest north or south--the pairs of tides tend to be more unequal. The rhythm of the sun's effect, however, is on a very different schedule from the moon's.

The whole earth-moon-sun system, it seems, is more than just a bit catawampus. Fortunately, the various cycles involved do exhibit a modicum of regularity and return to a point where everything is aligned more or less as it was before every 18.6 years or so.

End of story? Hardly! The trouble is the earth is not a smooth ball covered by an even layer of water. Continents and islands block and channel the tidal flows of water in complicated ways with big effects. This is what nearly got me into trouble 15 years ago. I didn't understand the huge role that geography plays in the tides and that the tidal range at Telegraph Cove was twice as great as I was used to seeing in California.

To really understand what the tide is going to do at a particular geographical location, you have to make tidal measurements at that place day after day for a very long time, in fact for the entire 18.6-year astronomical cycle. The results of these observations must then be corrected by comparing them with the astronomical theory of tides. This is because the tides you actually observe from day to day are strongly affected by weather phenomena that are flagrantly unruly.

Storm surges caused by strong, sustained flows of onshore or offshore winds can heighten or diminish tides considerably. Just think of the storm surge that obliterated most of the coast of Louisiana last fall if you want an extreme example. High-pressure atmospheric conditions can also depress sea level measurably, and deep low-pressure systems can cause tides to increase in height. Tides can also be significantly affected by extreme flows from large river systems such as the Fraser.

Thinking about all this causes me to regard with gratitude and respect the small army of folks whose work has enabled Fisheries and Oceans Canada to produce the amazingly reliable tide and current tables depended upon by so many people year after year.

If you're interested in digging a bit deeper into tidal theory, you might want to check out a very good site on the web put together by the US government's National Ocean Service: http://140.90.121.76/restles1.html. It's more complex than what I've presented here, but it's authoritative and contains some very helpful graphics.

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Natural Mysteries

November's mystery was: Just past the end of Georgia View Road there is a tall conifer with a different kind of growth close to the top. Does anyone know what this is? A couple of astute readers identified the growth as a mistletoe infection. Dwarf mistletoe (*Arceuthobium* sp.) lodges in a conifer tree and sends its "roots" down into the wood in search of nutrients and water. The tree often responds to this parasitic insult by sending out a bunch of shoots, known in forestry as a "broom". Though foresters consider the plant a bane, mistletoe provides food and home to birds and insects and can be part of a healthy forest ecosystem. Although our local dwarf mistletoe is quite different from the American mistletoe (*Phoradendron* sp.) usually associated with Christmas kissing, we had reports of some optimistic Naturalists standing around under that tree on Georgia View on Christmas Day, a look of serene hopefulness on their upturned faces.

This month's Natural Mystery: When we catch mice in our pantry, we put their little carcasses out on a stump or rock in the field, and ravens swoop down and carry off the snack. But not lately. The scavenger birds have been ignoring the mouse offerings this fall, and the little bodies stay out there for a week or more before disappearing. What's going on?

Have an answer? Send your thoughts to galianonaturalists@gulfislands.com. Have a Natural Mystery of your own? Let us know, and we'll try to answer it.

THE GALIANO NATURALISTS are a group of curious explorers who enjoy observing, marveling, and sharing information about the natural world around us. Come join us. (galianonaturalists@gulfislands.com)