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HURRICANES

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THEIR NAMES

Until one of these tropical storms hits right in your own backyard, it's just another weather phenomenon to be idly discussed with your next-door neighbour. In such discussions during these past couple of years one point of considerable curiosity has been the weatherman's recent habit of assigning feminine names to the hurricanes. When prodded long enough by members of the fair sex we have been known to suggest that hurricanes are among the most unpredictable of meteorological accidents, that they never seem to be able to make up their minds where they want to go next, that mere man (weatherman, that is) finds it well-nigh impossible to keep up with their changing moods, tempers and caprices ... unpredictable, vacillating, capricious ... surely these indeed are attributes which sufficiently justify us for treating them as feminine in nature. Such masculine reasoning is, of course, not allowed to go unchallenged. Graphic evidence of this may be seen if I may be pardoned for a moment to read directly from a letter which I received after one of our local newspapers quoted me in the foregoing tongue-in-cheek vein. Just after the occurrence of this year's Hurricane Carol a slightly perturbed lady wrote me as follows:

"I wish to enter a protest about naming hurricanes after females. Everyone knows that men are bigger "blows" than women. I feel that it is an insult to what is generally considered as the "weaker sex" to give a feminine name to such a rambunctious, destructive, altogether obnoxious display of elemental fury. Why not name the next one "Elmer" or "Ivan the Terrible" or something similar? Certainly nothing could be more inappropriate than "Dolly", for instance, which name immediately conjures up in my mind a little fluffy-haired, blue-eyed, demure blonde, scared of a mouse and who wouldn't hurt a flea. Where are the things named anyway? Is it in Ottawa? Trusting you will take appropriate steps to have the matter rectified in the near future !!! I remain, etc., etc."

Seriously, though, we weathermen had no ulterior motives when we began designating hurricanes by names. It was simply a matter of convenience. You see, there are those occasions when more than one hurricane is on the loose at a given moment. In such instances there is the possibility that serious mistakes may occur if the warnings issued by the various weather bureaus became confused because of mistaken identity. At one time the storms were referred to simply as A, B, C and so on, and we used the phonetic alphabet to talk about them, that is, we spoke of ABLE for A, BAKER for B, CHARLIE for C, and so on.

But then certain international organizations made changes in the phonetic alphabet and the risk of confusion arose once more. Meanwhile, during World War II the American meteorologists assigned to Pacific duty had begun the fashion of assigning human names to identify the hurricanes of that ocean ... typhoons, they're called there. It may be that they were influenced by the novelty of the literary device which had been used by George Stewart in his extremely readable book "STORM"; those of you who have read it will recall that the heroine, or perhaps it would be better to call her the villain, of that novel was a storm named Maria. Be that as it may, the Pacific typhoons for several years have been given names ... girls' names if they spend their lives in the North Pacific, and boys' names if they're born, live and die in the South Pacific. By means of a reasonable sort of logic it was quite natural that when the idea caught on in the Atlantic the North Atlantic hurricanes be feminine in name as counterparts of those in the North Pacific. The Atlantic Ocean doesn't have any male tropical storms simply because there are never any hurricanes in the South Atlantic.

Just before I leave this business of names, I might add a brief foot-note. Because of the effects of the rotation of the earth the females of the hurricane world spin away from the equator to the northwest. The gentlemen of the species also travel away from the equator, but towards the south. Consequently, Typhoon Tessie and Hurricane Harry are fated by nature never to meet. You know, as I sit at home on a quiet evening and contemplate the whims and fancies of these whirling storms, I've occasionally reflected casually about this trick of fate which prevents Mama Hurricane from ever getting together with Papa Hurricane and I've wondered just how there ever happen to be any baby hurricanes. But that's another story that I'll get around to in a few moments.

HISTORICAL HURRICANE ITEMS

1954 has been a year to be remembered in Canadian hurricane history with three of them, Carol, Edna and Hazel, having made invasions of our nation. By simply transposing some of those number, 1954, we can reach back to the year 1495 at which time we come upon one of the earliest records of hurricanes in the New World. In that year Christopher Columbus made one of his voyages across the Atlantic. Just at the time that he decided to return to Spain in October a terrible storm swept the island of Santo Domingo. Three ships at anchor in the harbour were sunk, and others were dashed against each other and driven as wrecks against the shore.

However, by 1502 Columbus had apparently picked up some knowledge about the advance signs of hurricanes, either through his own observations, or by conversation with the natives. On June 29th, 1502, Columbus arrived at Santo Domingo on his last voyage. He sent an officer ashore and requested permission to shelter his squadron in the river as he felt that a storm was approaching. His request was refused. Columbus then sent a second message warning that another fleet which was about to sail for Spain should delay its departure because he was certain that the signs pointed to an approaching violent storm. This request was just as fruitless as his first one. The weather, as is often the case just before the arrival of a hurricane, was fine and settled. But the predictions made by Columbus were all too true. The other fleet set out confidently to sea, headed for Spain, and was entirely lost except for one ship. Columbus' ships rode out the storm and experienced various degrees of damage.

The course of some of our own Canadian history has been shaped to a marked degree by one of these autumn storms. In 1745 the fort of Louisburg, on Cape Breton Island, fell to a party of New Englanders under Sir William Pepperell, assisted by ships of the Royal Navy. Louisburg at that time was the greatest French fortress east of Quebec. A fleet left France the next spring under Duke D'Anville for the purpose of recovering Louisburg for the French. To begin with the expedition encountered westerly gales which slowed down its progress so greatly that it didn't reach this side of the Atlantic until September. September is the worst month of the year so far as North Atlantic hurricanes are concerned. In 1746 one hit near Sable Island, that famous graveyard of the Atlantic located 175 miles east of Halifax. It dispersed the fleet and only a handful of transports arrived at Chebucto, now known as Halifax. A few days later D'Anville died, some say of a convulsion, others of a broken heart at the loss of his fleet. The crews that were left suffered from disease but the fleet nevertheless weighed anchor and sailed on October 13th with the intention of attacking Annapolis. Once again the French were doomed to disappointment. Off the southern tip of Nova Scotia they encountered another severe storm, which dispersed the ships once more and compelled the few that were left to return to France. The vital blow, of course, was that of September 16th. It was undoubtedly a hurricane and it was a major factor in the final destruction of the power of France in North America.

Our East Coast has been hit by many hurricanes, although not always with history-making effect. Some of them, though, are still well-remembered as, for example, the Saxby Gale of October 1869 which caused great destruction and some loss of life, and the even more punishing blow of August 1873 which brought about the loss of over 1,200 vessels in the three Maritime Provinces and the colony of Newfoundland. However, to list even only briefly all of the significant storms of this nature would exhaust our time this evening, so let's move along and investigate some of the characteristics of the hurricane itself.

HURRICANE CHARACTERISTICS

The first universal fact which becomes evident in a study of hurricanes is that they are born only in tropical regions, a feature which is, of course, responsible for the fact that we also call them tropical storms or even tropical hurricanes. Secondly, we know that they develop only over water; being tropical water it is obviously warm water. As a matter of fact, some recent work has shown that 81°F. seems to be a critical temperature and that hurricanes will not form unless the air in contact with the water has a temperature of at least 81°F. In the North Atlantic the hurricane season lasts from May to December. There are relatively few towards the beginning and end of their season; they build up to a peak in point of numbers in the month of September, with October running a fairly close second.

When hurricanes are fully developed they are the most destructive of all storms. This is because of their great size and savage intensity. Actually, the winds of the tornado blow with greater force. However, the width of a tornado is quite small; on the average, one would be confined to a path a little less than a quarter of a mile wide. On the other hand, it is not unusual for the violent winds of the hurricane to cover thousands of square miles.

At sea these storms are accompanied by mountainous waves; along the shorelines they cause high tides which flood coastal regions. In some cases storm waves break on the shore like a wall of water and have wiped out whole cities and towns. One of the most severe of these storm waves has drowned 100,000 people, with an equal number dying later as a result of disease brought on by the inundation. Property damage was proportionately huge.

The characteristics of the hurricane's wind pattern are something like this. At the outer fringes of the storm area the winds are gusty, but less than twenty miles per hour. As they move inward towards the centre of the hurricane the speed increases gradually. Squalls are followed by furious gales, and finally, if the hurricane is a severe one, the winds immediately surrounding the centre whirl at tremendous speeds. These winds create huge seas; the tops of the giant waves are blown away in sheets and spray, so that the sailor can scarcely tell where the ocean ends and the atmosphere begins. Ships are frequently carried to the ocean bottom, as was the tragic case this past summer in connection with a ferry operating in Japanese waters, and the loss of human lives may be heavy. When the hurricane moves onto land the crops in the field and the orchards are destroyed, buildings are wrecked, trees are uprooted and the wreckage is carried along with the wind. By the time hurricanes reach Nova Scotia they are in their decaying stages but even so the type of damage that I've just been describing is all too frequent in the beautiful Annapolis Valley, where the apple crop has been partially destroyed in each of the past two years.

Speaking of the hurricane winds, it's not easy to measure them, even approximately. As you can well understand, it becomes extremely difficult to estimate the speed of winds when they surpass one hundred miles per hour. Furthermore, it's almost equally difficult to measure such winds. Instruments which will be strong enough to withstand the force of hurricane winds, and yet be sensitive enough for average winds, are not easy to manufacture. In many violent hurricanes the wind instruments have been damaged or blown away before the highest storm winds were experienced. In some cases the steel towers which supported the instruments were wrecked. In other instances the buildings on which the instruments were exposed have been destroyed or unroofed. However, from the records which are available it is quite certain that over a sustained period of several minutes the winds of the hurricane sometimes blow at an average rate of more than one hundred fifty miles per hour. Furthermore, weathermen are confident that the gusts of the hurricane create air movements for brief intervals that may reach as high as two hundred fifty miles per hour in the most violent storms.

In regarding or hearing accounts of hurricanes you've no doubt come across the expression: "Eye of the storm". This so-called eye is the calm central region around which the highest winds blow. If you should happen to be in the direct path of the centre of the storm, you would experience a sequence of wind development such as that which I described a few moments ago. As the centre approached the winds would build up to a climactic crescendo, then at the "eye" itself there would be a sudden calm, but soon the winds would begin abruptly again blowing with great violence, but now from the opposite quarter from that at the beginning of the calm period. On the average the "eye" is about fourteen miles across, but of course there are great variations from storm to storm.

Some surprising events often occur in the calm hearts of these tempests. For example, when the "eye" passes over a ship near land, sometimes flocks of birds, and occasionally butterflies and other flying insects, land on the deck and rigging. Some ships have been nearly smothered with such aerial visitors. The reason for such a phenomenon is that the hurricane's winds are so violent that any living thing caught in them is powerless to battle against them, and is carried willy-nilly wherever they blow. As the hurricane's winds spiral towards the centre of the storm, anything caught in such winds will eventually reach the calm "eye" of the storm. Once there, they are unable to break out and must remain until the hurricane subsides. When, therefore, this "eye" passes over a ship it's but natural that any living creature it contains should land on the vessel to rest from its life-and-death struggle with the elements.

Inevitably a similar sort of situation comes to pass over land. Only recently I had a telephone call from a bird-watcher in Halifax who wanted some details about the path of this year's Hurricane Edna which roared through the Maritime Provinces on September 11th. At that time of year many summer birds are on their autumn migrations to Central and South America. Three different species showed up immediately following Edna's passage. There was a virtual shower of yellow-bill cuckoos; they have been reported from many sections of Nova Scotia where they had never been seen before. Likewise, the red-eyed towhee is a stranger to our East Coast province but showed up in mid-September. The scarlet tanager is not a frequent visitor, either, but one was found in an exhausted condition on the streets of Halifax the morning after the hurricane and it is now being cared for in the basement of my friend's home. He has also told me that after one of last year's hurricanes four of the yellow-bill cuckoos showed up in Scotland, evidently having been carried right across the Atlantic.

This year's crop of hurricanes made so many headlines and caused so much destruction that many folks have gained the idea that there has been an abnormally large number. In actual fact there is quite good evidence that the frequency of West Indian hurricanes has not changed materially since the days of Columbus. In some years of the present century there have been many and in others few, as was evidently the case in earlier centuries. In the sixteenth and seventeenth centuries comparatively small numbers were recorded. That's not surprising, though, because the coastal and island areas subject to hurricanes were sparsely settled. At that time it was possible for a hurricane of considerable diameter and intensity to move across the Gulf of Mexico or Caribbean Sea and pass inland without coming in contact with ships at sea or going near enough to a settlement to cause winds worthy of historical note.

However, during the twentieth century the records are fairly good, and they indicate that on the average there are about seven tropical storms per year. However, from year to year there's a wide variation. 1933 had the greatest number when twenty-one of them developed. There have been five different years this century with the smallest number: in each of 1911, 1914, 1917, 1929 and 1930 there were but two hurricanes. Last year and this year were quite normal with respect to total number, as eight tropical storms put in an appearance in eastern North America or its adjacent waters.

Now, then, I've described a few of the more interesting characteristics of the hurricane. If there were time, there are a number of others that I might dwell upon, for example, the cloud structure, the rainfall pattern, the barometric pressure readings at their centres, the occurrence of lightning and tornadoes within the hurricane, and so on. Then, too, there are still many features concerning which our knowledge is still very limited or even non-existent. You'll recall that I pointed out that a tropical cyclone is essentially a weather system which occurs, or at least is born, over the sea. Therefore, as a rule, the highly important observations of conditions in the higher atmosphere are relatively sparse over large areas in which hurricanes travel. Even in the West Indies and along the southern coasts of the United States, where upper air sounding stations do exist, it has been extremely difficult to obtain upper-air observations within the storm area itself.

You can readily understand, then, that scientists three hundred years ago knew practically nothing about them. Before the 17th century these tempests were known only as extremely strong and destructive winds. The fact that the winds blew in a rotary fashion around a central core was not even suspected. I've mentioned that the Spaniards had an experience with a hurricane back in 1495. They saw the terrible destruction which it wrought but they were quite unaware that the storm possessed whirling winds. The whirling nature of these gales seems to have been first mentioned in a book, published in 1650.

Toward the close of the same century somewhat more accurate accounts of the anatomy of cyclones were published. Captain Dampier gave an account of an Asiatic typhoon through which he passed and he described the calm area at the centre. He pronounced the storm in question and all other typhoons to be whirlwinds.

That these storms travel over the surface of the globe while their winds revolve about a centre was not recognized until more than a century later. It's hard to understand how this fact could have escaped observation so long. Many cyclones that occurred in the meantime were the subjects of long and detailed descriptions, from which an attentive student might have suspected that there were two movements involved. I realize, of course, that even today there is occasionally some confusion because people don't differentiate between the rotary and the progressive movements of a hurricane's winds. But if the hurricane is compared to a top, this difficulty is easily solved. The swift spinning of the top is the equivalent of the hurricane's spiralling winds; the slowly changing position of the top relative to the ground is comparable to the slow progression of the hurricane across the sea.

FORMATION OF HURRICANES

One of the facts which still puzzles us greatly is the method of formation of these storms, and that, of course, is a most important fact. As they form only during certain seasons of the year it might be thought that we would know exactly how they form. This is not the case. There are certain theories, of course, but they are not definitely proven. As I've already drawn to your attention a couple of times, one difficulty is that hurricanes develop over the tropical oceans where there is a scarcity of reliable weather information. In practically every case the wind system around the hurricane centre is already quite definitely established before we get an inkling that a new cyclone is forming. However, the very fact that hurricanes do develop in certain restricted regions does give us a clue. As they are born over the warm sea, and as they usually disintegrate rapidly after moving inland, it would appear that they must have a large supply of water vapour available if they are going to amount to anything.

I don't want to spend too much time dealing with meteorological theories but I think that we should at least glance at the ideas which have been put forward to account for the birth of one of these awesome storms.

First in point of historical sequence is the so-called convective theory. Now I don't want to frighten you with unfamiliar words so let me pause for a moment to give an everyday example of the convection process. You know those large white fluffy clouds which appear in the sky on a fine summer afternoon. They are convective clouds. The heating of the lower atmosphere through its contact with the warm surface of the earth causes the parcel of air at the surface to become less dense than the air around it, and it rises. This rising current of air is called a convection current.

The convective theory of hurricane formation was developed many years ago and it was quite generally accepted until the early 1930's. According to that hypothesis the sun beats down over a calm ocean in the region of the doldrums west of the Cape Verde Islands, off the west coast of Africa. Enormous volumes of heated air saturated with ocean vapour rise from the warm surface of the sea. At first the air ascends gently because its buoyancy is slight. As each molecule mounts, another moves in from the side to replace it. The motion is moderate but on a vast scale. The earth's rotation gives a spin to the rising currents and as the warm air spirals to higher levels of lower pressure it expands. With expansion comes cooling; with cooling comes precipitation. From precipitation comes latent heat to rewarm the air and quicken the movement. Light air flowing gently over the surface of the ocean becomes a breeze, increases to a wind, mounts to a full gale rotating counterclockwise. Thus a hurricane is formed.

There's only one thing wrong with this theory. There are very few meteorologists today who will defend it because there are too many facts which it fails to explain. For one thing, many of the heaviest tropical rainfalls occur without the existence of a low pressure system with its rotating winds. Furthermore, there are many cases in which a low pressure system does exist and torrential rains occur within it but, and this is the crowning blow so far as this theory is concerned, the low pressure system does not even intensify, much less develop into a full-fledged hurricane.

Therefore, most weathermen today are satisfied that the convective theory does not give the whole answer even though we do not deny that these upward currents of air are necessary for the generation of tropical storms, that is, they are necessary as one factor, but they are not the sole ingredients which make up the witch's brew from which a hurricane develops.

The next theory to be put forward was the one which is called the frontal theory. This was suggested during the mid-1930's and it was really an extension of the reasoning which we use to explain the everyday storms which form in our temperate latitudes. As those of you who watch the daily story of the weather unfold on your television screens know, the common run-of-the-mill storms which we experience hereabouts at this time of year develop at the boundaries between two different masses of air. On the one side we have a huge body of cold, dry air which has surged down out of the Canadian northland. On the other side we have a vast mass of warm, moist air which has drifted up out of the sub-tropical regions. Where these two air masses meet there is a dividing surface which we call a front, with two streams of air flowing side by side but in opposite directions. A disturbance takes place on this front, perhaps because it runs into some obstacle such as a mountain on the earth's surface, perhaps because of some events which are taking place in the atmosphere miles above our heads, but whatever the basic cause a new storm develops on the front.

Down in the tropics there is also a zone where air streams meet. There on the one hand are the northeast trade winds, and on the other are the southeast trades. Where they come together there is a zone sometimes called the intertropical front or the intertropical convergence zone. Regardless of what we call it, though, there are those meteorologists who suggest that hurricanes may well form on this intertropical front just as our everyday storms form on the polar front. One objection which is immediately put forward against this theory is that the air in the southeast trades is almost identical with that of the northeast trades, whereas in our latitudes there are great differences in both temperature and moisture content between the air masses on either side of the polar front. In other words, say the opponents of the theory, you just do not have the type of contrast between the opposing trade wind air currents that is necessary for storm development. To counter this objection the upholders of the frontal theory state that it is true that there is little difference between the two air masses but that the difference is enough to act as a trigger and to set off the convective process required by the old convective theory. At this stage of the argument the doubting Thomases again point out that strong convection is not sufficient to give birth to a hurricane.

So let us leave those groups arguing merrily and move along to the third and latest theory which has been advanced. It has been picking up supporters only during the last five years or so and there is certainly still not sufficient evidence to justify us in believing that it is the last word on the subject. It's rather complicated and involved, so I shall do no more than outline it very briefly. It departs from a study of the atmosphere only at the surface of the earth and it requires us to pay strict attention to what is happening at higher levels. In other words, we have to attack the problem in 3D. When we do this we begin to find evidence that there are certain patterns of high and low pressure aloft which will tend to bring about the continuing development of a weak surface tropical disturbance. This theory is gaining more and more supporters and there are undoubtedly overpowering reasons why we must agree that the formation of hurricanes can be explained logically only if we take into consideration the interaction of forces at all levels of the atmosphere. Suffice it to say for the time being, and I realize full well that I'm not really increasing your knowledge one iota when I say that, when certain critical conditions happen to occur simultaneously at various levels throughout the atmosphere, at least up to heights of twenty to thirty thousand feet, then a hurricane forms.

FORECASTING HURRICANE MOTION

As we're still not certain why hurricanes form, it is readily apparent that we're not in a very strong position when it comes to forecasting that a new tropical storm will form. Fortunately, this is not a very serious handicap. After all, the beginnings of a tropical disturbance are not serious. At birth they are quite harmless, since at that stage the winds they possess are still weak. In addition, I've already pointed out that they usually form in a region where there is little shipping and even less habitation and thus in their formative stages they do not pose any threat to human beings or their property.

Once the hurricane has formed, though, it does become extremely important to the weatherman that he locate it as quickly as possible and that he forecast its development and motion with a high degree of accuracy. Those weather forecasters who are responsible for keeping an alert watch for new hurricanes are able to spot quickly any suspicious developments in the tropical waters of the North Atlantic. Once they have decided that there is a baby hurricane out over the lonely wastes of the tropical ocean they are able to call upon other specialists to help them out. I'm referring now to the glamorous hurricane-hunters ... those special squadrons of aircraft and aircrew maintained by the United States' armed forces who fly into the heart of the hurricane to find out both visually and by means of the latest radar equipment just where the storm is located.

Having pin-pointed the exact position of a new hurricane somewhere between the West Indies and the African coast the forecaster is faced with the problem of predicting its future behaviour. This is one of the most challenging and exciting, yet frequently exasperating, problems which can be placed before a forecaster. Hurricanes tend to be rugged individualists in their actions and they seem to delight in breaking all the rules which have been set up to cope with them. There is a certain broad pattern into which many of them fall, but the forecaster can never be certain that any given Alice or Florence will behave as her sisters have done in the past.

In view of the fact that a difference of position of only fifty miles can make the difference between terrific destruction and only a heavy gale with minor damage, you can readily appreciate the importance of forecasting their future course with almost superhuman exactness. Yet there are so many probabilities.

Remember that most of the hurricanes are born near the African coast. First they amble slowly westward across the Atlantic; then as they reach the vicinity of the West Indies they may take one of several paths. They may continue to move in a westward course and eventually commit suicide by hurling themselves against the mountains of Central America or Mexico. They may sweep in a broad northwestward curving arc through the Gulf of Mexico into Texas or Louisiana, meanwhile striking a glancing blow of terrific force at Florida. They may turn more sharply northward as they approach Florida and move northward along the North American East Coast. They may take this latter curving route at an even earlier stage and thus not affect North America at all. They may combine the features of two or more of these paths. Perhaps a few examples of the paths taken by some hurricanes of the past will illustrate much more graphically than words just what I mean. (See attached chart of Hurricane tracks.)

In view of all these probable tracks I think that you will agree that each new tropical storm poses a problem of considerable complexity. Let it not be forgotten, either, that the track is only one variable with which we must cope. It is necessary to forecast the speed with which the hurricane will advance. As I've hinted, they meander quite slowly westward from their point of birth, travelling along at perhaps ten or twelve miles per hour. When they begin to alter course to a more northerly direction they usually slow down markedly, to four or five miles per hour, or they may even wallow almost motionless for a day or more. Having elected a definite track towards the north, they speed up again and chug along at ten to fifteen miles per hour once more, until they arrive in the region of the westerlies at which time they begin to accelerate rapidly and may take on a rather reliable forward motion of twenty-five to thirty miles per hour, or even a phenomenal rush of fifty or more miles per hour. Let me stress again that I am now speaking of the speed of forward motion of the entire hurricane, not the speed of the winds whirling about its centre.

For the sake of argument let's assume that a forecaster has determined with amazing accuracy the future path and speed along that path of the hurricane. His problem is by no means solved yet. Now he must decide how the character of the storm itself will change; will it weaken or will it continue to become more violent for some time yet? Will it spread out to cover a larger area and if so how large? What will be the strength of the strongest winds when the storm arrives in his district of responsibility? What will the rainfall pattern be at that time? To what extent will the tides be affected? These and many more answers must be found if the public is to be provided with the greatest amount of helpful warning.

Fortunately, there are some rules which have been discovered which help the forecaster solve his multiple problem. To an ever-increasing extent we are receiving help by turning to the wind currents at higher levels in the atmosphere and determining how they steer these storms along. It was by means of the application of these forecasting rules and the sifting of every available scrap of weather information that the Halifax office early this autumn was able to forecast with well-nigh perfect accuracy the track, motion and intensity of Edna long before she crashed through the Maritimes, and that the Malton office in October did so fine a job of forecasting the route which Hazel took, erratic though that route was.

ONTARIO HURRICANES

Speaking of Hazel, I believe that there were many residents of Ontario who had the impression that a hurricane could never do any damage to this province, that it was sheltered by so great an expanse of land to the south and the east that only very slight secondary effects could ever be experienced as the result of a dying hurricane's passage. When she wrought the tragedy that she did there was a general feeling that it was an unprecedented event. This, of course, is not the case. A survey of the first fifty years of the 20th century has revealed that, in all, some two hundred forty hurricanes have struck the mainland of North America. Of these, a total of twenty-five travelled sufficiently far inland to affect this province, and eight of them might be classed as extraordinary storms, either with respect to wind or rainfall, or both.

In the first year of the present century Ontario felt the effects of the hurricane which has gone down in history as "The Great Galveston Storm" because it killed over six thousand people in that Texas city. In the closing days of its life it crossed Ontario between Toronto and Muskoka causing great damage to the fruit crops and orchards, and wrecking many ships on the lakes.

Fifteen years later another tropical storm followed a remarkably similar path but it brought little wind to these parts. It was moving very slowly as it approached Canadian territory and its effects were felt in the form of excessive rainfall, with the amounts that fell having been in the same range as those which Hazel brought.

I shan't go into any detail concerning the others, but shall mention simply that damaging hurricanes paid visits to southern Ontario in 1923, 1932 and 1941.

HURRICANE HAZEL

Let us now turn to Hazel. I think that everyone agrees that it was not the strength of the winds that she brought to the Toronto area which caused the disastrous events of October 15th, but rather the torrential rains which fell on land already waterlogged by weeks of persistent precipitation.

Hazel was first located by a reconnaissance aircraft on the afternoon of October 5th. At that time she had already gained a respectable age and was packing winds near her centre of ninety-five miles per hour. She was found about thirty miles east of Granada, the southernmost of the Windward Islands. At that time she was moving along a rather erratic westward path and on the morning of the 7th another aircraft penetrated to the eye and found that winds were up to 115 miles per hour. The following day aircraft surveillance indicated that the westward motion was being maintained and that the strongest winds had picked up to 125 miles per hour. On the 10th the hurricane hunters flew to the centre once more and found that a change in storm track to the northward was taking place. With the shift to north there was the usual simultaneous decrease in speed of forward motion. On the 12th and 13th she crept through the channel between the eastern tip of Cuba and the western tip of Haiti. As her edges battered against the mountainous land bordering the channel the storm lost some of its intensity, but later on the 13th, after regaining the open water surrounding the Bahamas, she began to strengthen again. Then, during the early morning hours of the 14th, Hazel put on her running shoes and she speeded up along a north-northwest track. Bulletins began to flow out from the Miami Weather Office warning the southeast coast of the United States. That evening the Boston Weather Bureau also got into the act with a preliminary warning to New England interests who had already been hit a knockout blow by Carol and a glancing wallop by Edna.

From that point onward I think that I may assume that you are already fully aware of the sequence of events. Early Friday morning the Malton weather office forecast that the storm would move over Lake Ontario and into this province. With great accuracy the forecasters predicted the diminution in wind speed which would occur as the tropical monster moved over the North American land mass and particularly the Allegheny Mountains. Then, too, the forecast specified the continuation of the heavy rain which had already been falling long in advance of the hurricane's actual arrival.

The deluge of rainfall was the result of an unfortunate combination of circumstances which again was far from unprecedented, even in recent years. For, out of the west came a mass of cool air. The leading edge of this cold air mass, the cold front, had been advancing steadily eastward across the continent, but as Hazel approached, it was first slowed down, then it stalled and finally it was pushed backward. The expanse of cold air to the west presented a barrier to the warmer, lighter air being brought from the tropics by Hazel. As the light air couldn't push the cold air bodily out of the way it glided upward over it. This lifting process perpetuated and increased the towering cloud masses from which record-breaking amounts of rain were falling. The ever-increasing accumulation of water on the ground on the evening of October 15th at long last led to tragedy.

But, as I said, a situation almost identical to this has happened before in my own realm of experience. On September 21st, 1942, a strikingly similar development took place along our East Coast. At that time a hurricane followed the off-shore track up the eastern seaboard and as it approached Nova Scotia it, too, ran head on into a cold front which had just moved into the Atlantic after crossing Nova Scotia. Throughout that autumn day and throughout that night the rain poured down in torrents and the city of Halifax received a wetting the like of which it had never seen before in recorded history. Almost $9\frac{1}{2}$ inches of rain fell that day, more than was reported from any community a month and a half ago in this locality. Fortunately, our terrain and drainage are such that no loss of life occurred and, furthermore, a surprisingly small amount of property damage was occasioned.

It might be added, also, that a survey of some of the earlier storms in this area indicates that just as much flooding of the four rivers in the Toronto region has occurred in the past as with Hazel. There was not nearly as much loss of life and property for the very simple reason that there was not as much life and property in the river flats to be lost.

FURTHER OUTLOOK

Before I close, let's look at the future. We are living in an age when man is striving more and more to conquer the elements and bend them to his will. Naturally, then, when destructive hurricanes invade our continent as Carol, Edna and Hazel have done this year we ask the question:

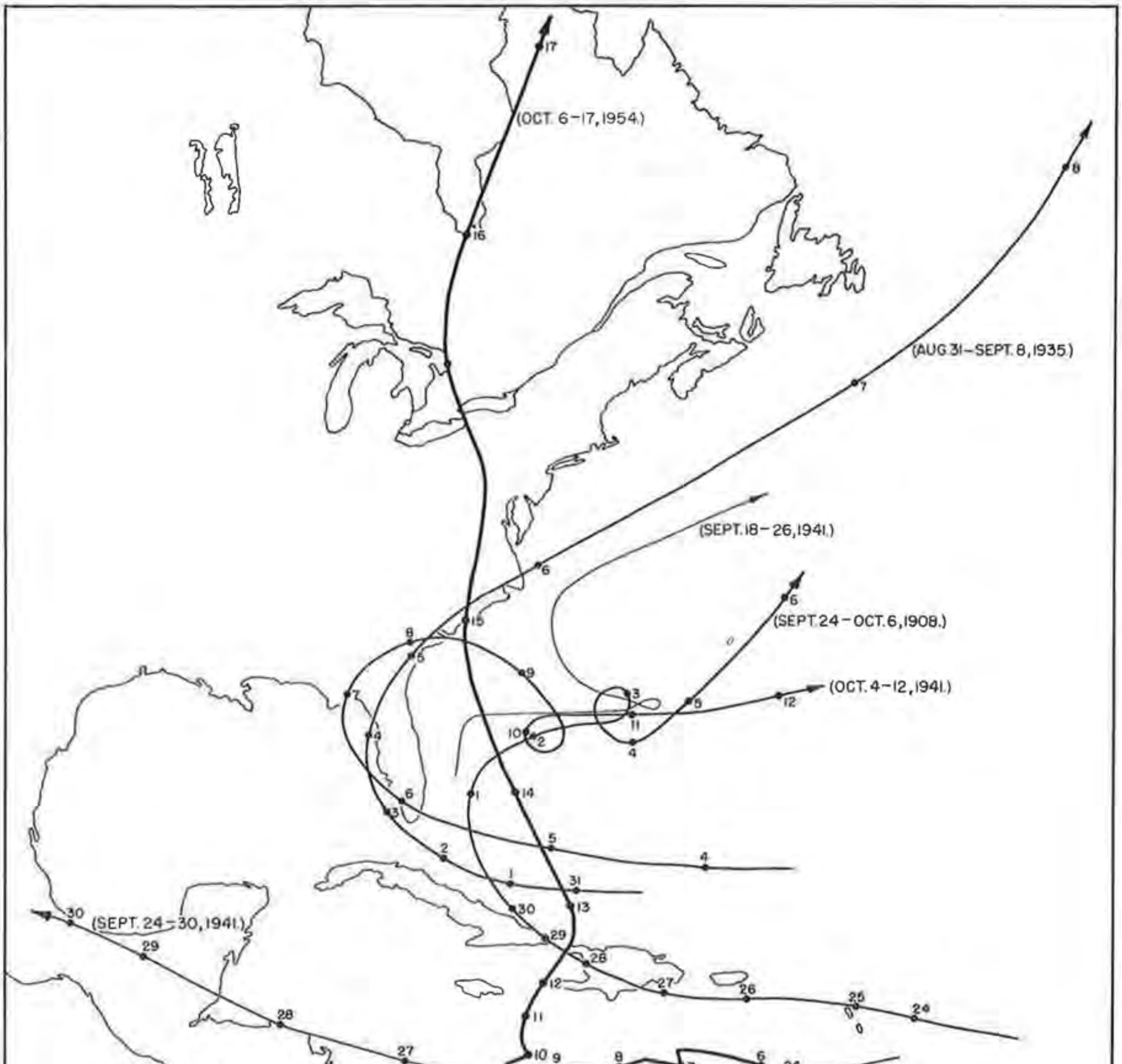
will it ever be possible to prevent the formation of tropical hurricanes? Naturally, too, there are those enthusiasts who rush forward to answer in a ringing affirmative.

Some of them think that they see the solution to the problem by engaging in a project of seeding the hurricane cloud in much the same manner in which they seed clouds in an effort to increase the natural production of rain. Their reasoning seems to be that if they could disturb the structure of the embryo clouds they might be able to disrupt the growth process of the entire storm. This dream overlooks the fact that the hurricanes are nearly always fairly well developed before we even find them. Assuming, though, that we could spot them at their first moment of conception, we must remember that some kind of natural rainfall release is already always active within the hurricane cloud system, and thus it is highly improbable that artificial cloud seeding will materially change the natural developments.

On the other hand, if it were possible to cover the surface of the sea with some substance which might prevent the cool hurricane rain from sinking down through the warm sea water we might have something. In that event we might force the storm to wipe itself out by having it cool the underlying surface of the earth, in this case the sea surface. If the lowest layers of the air could be kept below that critical temperature of 81°F the energy supply of the hurricane might possibly be quenched in the same way as is now the case over land, since the hurricane energy is derived from the immense supply of heat in the interior of the ocean. It is not too likely, though, that man will find such a substance in the near future and, thus, it is still in the realm of science fiction for us to be able to change the weather in this respect.

Also in recent years there has been the suggestion that we drop some of our atomic age bombs into the growing storm. This sounds to me very much like the legendary system of cutting off your nose to spite your face. The energy released by our present day bombs is still exceedingly small in amount in comparison to the order of magnitude of the energy which Nature expends in even one of the less violent tropical storms. As I see it, about all that we would be doing would be to compound the damage by releasing vast amount of radioactive wastes which would then be carried thousands of miles and showered down upon us with the rain.

In other words, if I may conclude on the same note on which I started, man may be successful in amassing a great number of facts about the characteristics, the structure, the birth, life and death of the feminine member of the species, but when Barbara or Katherine or Vicky gets the bit in her teeth it'll take much more than a mere man to tame her.



(OCT. 6-17, 1954.)
(AUG. 31-SEPT. 8, 1935.)
(SEPT. 18-26, 1941.)
(SEPT. 24-OCT. 6, 1908.)
(OCT. 4-12, 1941.)
(SEPT. 24-30, 1941.)