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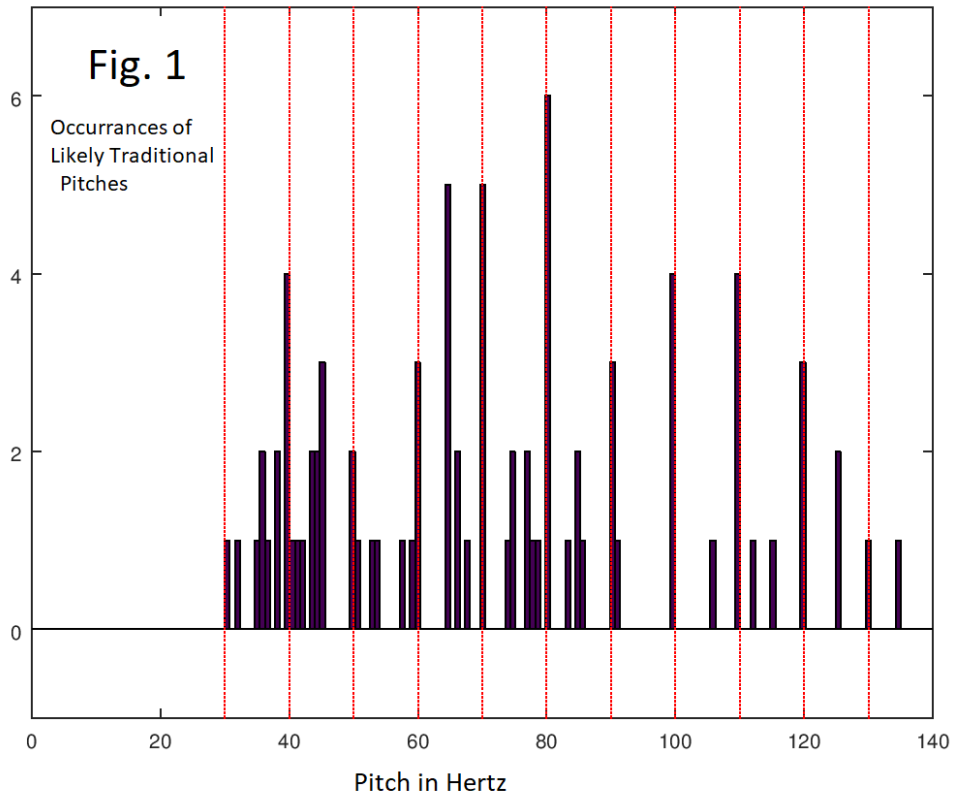
Histogram of the Pitch of the Hum: a First Look

-by Bernie Hutchins

In the last few years we have spent some space on the phenomenon known as the "Worldwide Hum", (or just "The Hum"), [1-13]. Glen MacPherson's website [14] has been largely responsible for the notable progress that has been made in understanding the phenomenon. Very recently he has released an updated version [15] of his World Hum Map and Database Project with a much improved (in many aspects) data base of hum-hearers, and invited researchers to explore it.



The data base has just been offered in a new form which has fewer data map points as of May 2018 (631 down from over 7000) but with some extra questions and with measures instituted to invite more carefully, better considered data. Working with only 600 point that are already somewhat "filtered" is more inviting than having to deal with the larger set.

My interest was to examine the pitch-match that Hum-hearers make (when they can do so well enough) to the Hum they "hear". This pitch is a "frequency" measured in Hertz, so is a number which can be put in a data vector and presented as a histogram. This is what is shown in Fig. 1 above. It requires explanation, perhaps starting by reminding the reader what a "histogram" is.

The horizontal axis is the pitch in Hertz [Hz, called "cycles-per-second" (a better name), some 50 years ago]. The histogram process (the program used to plot the graph) assigns pitches entered to the nearest integer. Plotted vertically are bars corresponding to the number of occurrences of that pitch value. For example, 80 Hz has 6 occurrences (the most), 100 Hz has 4 occurrences, while 99 Hz has no occurrences, and so on. It is no surprise that measurement errors and/or pure random scattering of the underlying phenomenon means that only the general shape of the distribution matters here. Here 66 of the 84 points (79%) are in the range of 30 Hz to 90 Hz, and there is no real indication to suggest that the distribution within this range is not basically flat – one would be hard-pressed to suggest a significant clustering about any value within this region.

But, with some 631 points in the data base, why only 84 in the histogram! Before the specifics comments regarding pitch, first recognize that not all data in the data-base lend themselves to presentation as a histogram. Many require a narrative answer rather than a numerical response (like technical training of the responder, or the geographical location where the hum is heard). No histogram there. One item, the responders age, is obviously ideally suited to a histogram. Still, in some cases, there may be a few outliers to discard ahead of plotting (people responding 1 year old or 199 years old, or something clever like "older than dirt"). In the case of pitch, we might (erroneously) suppose that everyone could give an accurate numerical response with much the same confidence one gives his/her age. NOT AT ALL.

Firsts, for pitch, there were many blanks – empty boxes or effective declinations to respond. (Of 631 possibilities, 108 left the box blank or said the program did not work for them.) Not everyone has the skill to pitch match (this is NOT a failure or criticism). In such a case, a blank is very appropriate. Being reasonably sure of giving a useful answer is important. A tool (an Online Tone Generator - OTG) was suggested for those (most of us) for whom pitch matching is a task. Here too, many responses were discarded. People did not understand what they were supposed to do (again – why necessarily should they?). So some folks apparently launched the OTG tool and it came up (as its default) as a 440 Hz sine. They were supposed to adjusts the frequency to match their Hum (which was perhaps 30 Hz to 90 Hz: much lower than the 440 Hz default. They often entered 440 Hz. Others said that the OTG options were all "too high" (apparently just punching the waveform choices). (Of the 631, 28 either said

440 Hz was the pitch or indicated fairly clearly that the OTG gave pitches way too high). Another 27 of the 631 reported something that clearly indicated they had not used the OTG correctly. No harm - these were just not put into the histogram. It should be noted that few people have previously experience pitch matchings down to as low as 50 Hz, let alone to a very weak tone, let alone to a tone which may well not even be real audio. It is encouraging that so many got a good deal accomplished.

Still others put in ranges, like 85-95 Hz. These were also discarded since putting in an average value like 90 Hz did not seem justifiable. The data contained a mystery as well: five people entered 44.1 Hz! Where did that come from? It seems unlikely they were from an actual measurement. (Very few people even gave the pitch to one tenth of a Hertz. That precision, and more, IS possible to do by using "zero beating" and a few folks, for their pitches, knew exactly what they were doing.) But five people at 44.1 Hz! (44.1 kHz is a digital audio sampling frequency, but I see no possible connection.)

So a lot of entries were thrown out on the basis of what we would consider to be imperfect or incomplete information. There would appear to be no good theory how this exclusion could change the results in any systematic way.

SEARCHING THE DATA LINE

The search was done of all 631 points. I quick run up and down the pitch column was an indication of what was likely to be most typical. Then, one by one, "Possibly Valid" points were examined. For example, if someone entered 68 Hz, I looked at the rest of the line for at least a preponderance of evidence. I **was** "mining" the data to see if there was evidence for any favored pitches in cases that seemed to be the "traditional Hum" which I believe is an internal "low-frequency tinnitus". That's all I was looking for. At the same time, in some cases, evidence of a real acoustical sound was found, and the corresponding pitch was not added to the histogram. Thus, to my checklist for the traditional Hum [12] I feel I have presented evidence that hearers in this class hear pitches, broadly distributed in the range of 30 Hz to 90 Hz. At the very least, there is no evidence of tight clusters. Other pitches suggest environmental noise.

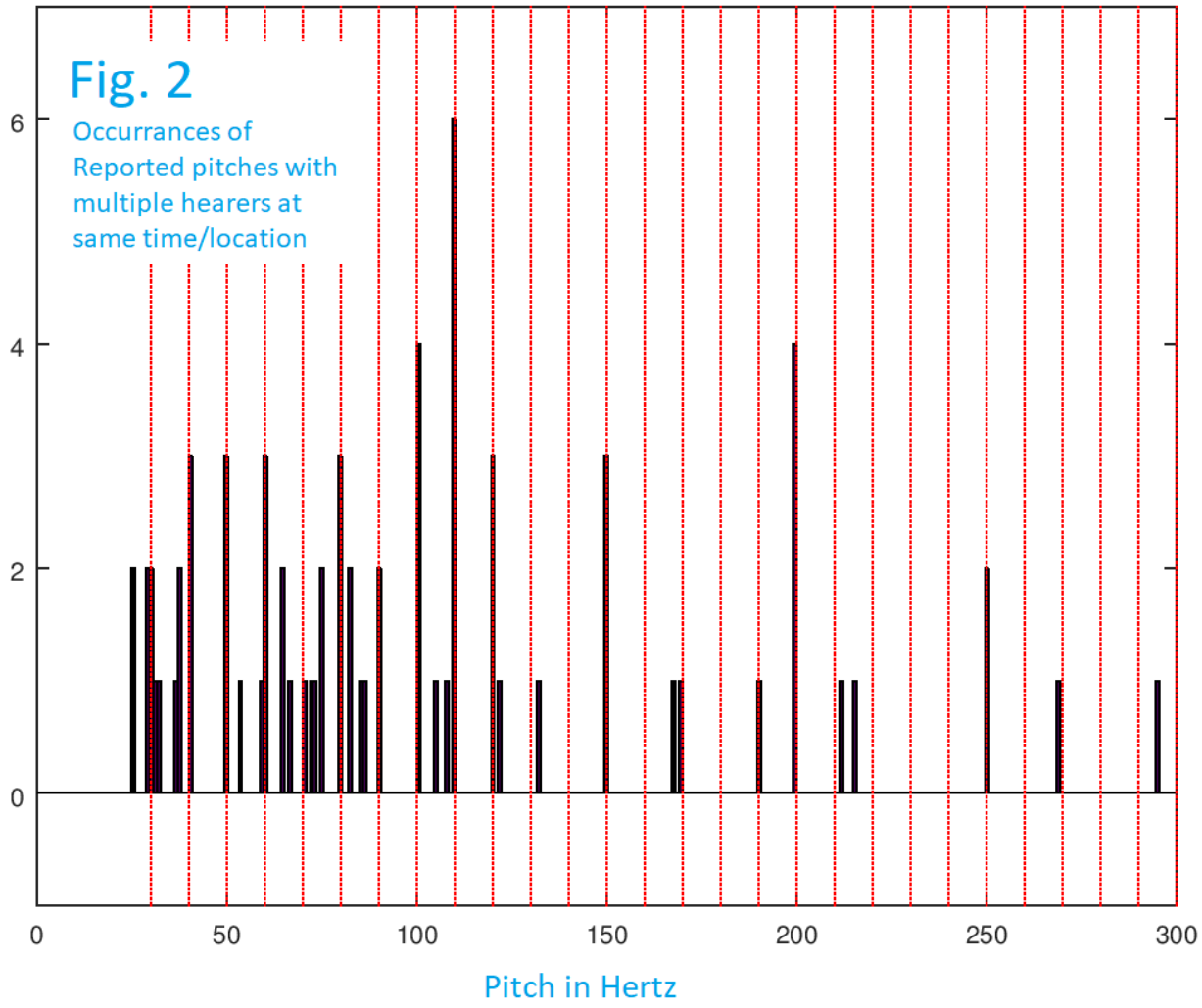
After what looked to be a likely in-range pitch, I next looked at the descriptions (narratives). I was looking for the classic "surging diesel in the distance", or that sort of thing, not the "boom of a party down the block"; and indications that it was, in the absence of some distraction, 24/7/365. Location mattered only if pitches were at or very close to 50 Hz, 60 Hz, 100 Hz, or 120 Hz. If these pitches were 60 or 120 in the US/Can, or 50 or 100 in the rest of the world, potentially we were encountering power supply effects, and tentatively ruled out.

This is a perhaps a good place to remember the "head-shake test" and the "alone test". Possibly the strongest test for an internal source is to shake one's head sharply and see if the Hum interrupts for about ½ second. If so, your head shake didn't pause a power generator blocks away! As well, if you hear a hum and others in the house do too, it is likely a real (external) sound. Thus if you are hearing 120 Hz, in the US, hear

a very steady hum (no amplitude surges), can't shake it down, and your whole family hear it, look for a loose electrical panel, not a personal low-frequency tinnitus. And – congratulations – you did your study correctly.

OTHER HEARERS AT TIME/PLACE

People entering their data were asked to respond with one of three options (Yes, No, or don't know) to the question about whether others at the same time and location also heard the hum. Since supposedly only 2% of the general population hear what we are taking here to be the traditional Hum, two people at random both hearing he Hum is extremely unlikely (probability 0.0004). Accordingly, a Yes answer was a disqualifier for the histogram of the traditional hum. Thus after finding a likely pitch, and finding the rest of the line looking promising, if I found a Yes for a second hearer I discarded the line, sometimes with reluctance. My impression was that I did this rarely (perhaps 20 times total). Apparently, I fooled myself.



It was easy enough to count the Yes answers and there were an astounding 187 of them (30%). Potentially, these could be mostly externally generated, and I had underestimated my initial impression of the number of Yes answers because I was already filtering for the traditional Hum. Indeed, looking at a few of the Yes answers I saw why they were already discarded. Of course, the flaws in many of these 187 entries would lead to continued disqualification.

Much simpler than examining for a traditional Hum, examining those who had companion hearers for their reported pitch was done with two interesting observations. First, there were a lot of disqualifications from the original 187 Yes answers: only 75 of the 187 survived (see histogram of Fig. 2). The rejections (blanks, problems with the OTG, etc.) used the same criterion as for the traditional hum. The second thing was that so many people wrote down pitches to the nearest 10 Hz (43 of the 75 or 57% did this), perhaps indicating a more difficult matching task. Compare this 59% for Yes hearers to about 39% who choses multiples of 10 Hz for traditional hearers. The overabundance of multiples of 10 Hz can be seen directly in BOTH histograms by the dashed red lines at these multiples and the higher bins. This shows that rounding was prevalent.

HEAD SHAKE

I was somewhat surprised that 37 of the 84 responders reported that the head-shake test worked. This was a good indication that people filling in a line were doing a conscientious job. If you gave a valid description of the traditional hum, and said that you could shake it down, you made the histogram unless you had a strong counter-indication (like others at the location hearing it as well). NOT passing the head-shake test was not enough in itself to keep you off the histogram, especially for those who said they were not sure – the test is robust once mastered, but still a bit subtle.

The issue of “beating” [16] turned out problematic. Without doubt a few hearers used zero beating, probably subconsciously, they zeroed in on the pitch by adjusting the reference frequency from the OTG or a laboratory function generator. In this case an objective amplitude beating may occur (real sound) or a subjective quivering or wavering (second-order beating) would be expected if the hum were internally sourced. In either case this “throbbing” is at a perceptual rate (low enough frequency) and is heard to slow as the reference closely approaches the hum pitch. The corresponding case where two musical instruments are out of tune is quite familiar even when incompletely understood. Of the 84 histogram point responders, 19 reported beating.

But – not all of these were likely real beating. A beating phenomenon may include amplitude fluctuations, or apparently does. The traditional Hum includes at least noticeable surges or fluctuations at a rate of 1-2 Hz. The beat fluctuation changes (slows) as the reference frequency approaches the hum pitch, from either direction, eventually stopping for practical purposes. The survey had no way of indicating this, although some did and used terms like zero-beating. A few however said that the beating they heard was the same (rate?) as the amplitude fluctuations in the original

hum. This was not beating, although it was good secondary evidence of the traditional Hum. This response to the beating question was never used by itself to disqualify a data point. As I said, some folks knew exactly what they were doing, and this was always interesting. One disqualified point was pretty clearly a 120 Hz power system buzz well identified by beating and by other factors (a house full of hearers).

IS THIS DATA COLLECTION AND THIS ANALYSIS BIASED?

YOU BET! It's unavoidable. For one thing, the reports are all from people who suffer from a very rare affliction and who found their way to Glen's website. And they were folks who took the trouble to contribute. Glen has admirably always been initially tolerant of "non-mainstream" suggestions while using his background as a scientific generalist to guide those who are merely naive. True science has a high priority.

In reading comments on Glen's site, we sometimes were struck with the thought: "Now, here's a well-investigate well-reported data point." Here I have aggressively tried to sort out similarly legitimate points from the data base.

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