What Sets the Wingbeat Is Not the Nerve but the Spring and the Mass

— With nerve impulses at 20 Hz the wingbeat is 200 Hz, a factor of 10.000000: one beat takes 5.000000 ms against 50.000000 ms between impulses — the separator is whether a command makes each stroke or merely sustains an oscillation — [Paper 831]

Yuuki YAMAGISHI (山岸 勇輝)
Yamagishi Complexity Torus Lab, Japan
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— *From thinking to syncing.* —

Abstract

Some insects beat their wings faster than their nerves fire.This paper counts that the speed is set not by the commands but by the resonance of a spring and a mass.No new theorem or law is claimed. First, the beat outruns the command——20 Hz against 200 Hz is 10.000000, or 50.000000 ms against 5.000000 ms (Section 2). **Second, and this is the core. The speed is written as a resonance——with an effective mass of 1.0×10^{-6} kg, 200 Hz needs a spring constant of 1.579137 N/m** (Section 3). **Third, moving the mass moves it as an inverse square root——four times the mass gives 100.000000 Hz and a quarter gives 400.000000 Hz** (Section 3). **Fourth, moving the spring moves it as much——1.0 N/m gives 159.154943 Hz and 2.5 N/m gives 251.646061 Hz** (Section 3). **Fifth, so the way to raise the limit changes——if commands set the speed one must fire faster; if resonance sets it one lightens the wing or stiffens the thorax** (Section 4). **Sixth, the separator is whether a command makes each stroke or merely sustains an oscillation——one phrase, "the muscle drives it", points at two mechanisms** (Section 4). **Keywords**: asynchronous muscle, resonance, spring constant, effective mass, wingbeat, representative values.

> **Scope of this paper (scope note)**: **No new theorem or law is claimed——that asynchronous flight muscle oscillates faster than the nerve fires, that it is activated by stretch, and that the thorax acts as a resonant system, are all known.Every value is representative——20 Hz for the nerve, 200 Hz for the wing and 1.0×10^{-6} kg for the effective mass are values chosen to see orders of magnitude.No real insect is discussed——species-specific frequencies, muscle microstructure and temperature effects are not treated.Aerodynamics is not entered——how lift is produced, vortices and wing shape are not the subject.No mechanism is claimed——the molecular basis of stretch activation is only named.Relation to earlier papers**: **Paper 326 showed that the square-cube "law" is an identity, not a law——this paper stands beside it: the frequency here is not a performance but the square root of a ratio.Paper 300 showed that whether two things share a root is decidable——"the command is fast" and "the resonance is fast" are distinct roots, and they call for different moves.**What is added is **counting the ratio of command to beat as 10.000000**, **deriving the spring constant for 200 Hz as 1.579137 N/m**, **listing how mass and spring move the resonance as an inverse square root**, and **placing the separator on commands that make strokes versus commands that sustain**.

1. Notation and the Question

Setting: **a system with spring constant k and effective mass m resonates at**

$$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$$

The nerve fires at 20 Hz, the wing beats at 200 Hz, and the effective mass is 1.0×10^{-6} kg.

Question: **is the wingbeat set by the rate of commands or by resonance?**

2. Faster Than the Command

Computation 2.1: **the two were compared in time.**

measured	frequency	time per event
nerve impulses	**20** Hz	**50.000000** ms
wingbeat	**200** Hz	**5.000000** ms
ratio	**10.000000**	**10.000000**

> **Observation 2.2**
>
> **one command per stroke cannot give this speed.Between impulses 50.000000 ms apart, the wing moves 10 times——the command does not make the strokes one by one; it sustains an oscillation.**

3. Writing It as a Resonance

Computation 3.1: **the spring constant was varied.**

spring constant (N/m)	resonance (Hz)
1.0	159.154943
1.58	200.054661
2.5	251.646061

Exactly 200 Hz requires 1.579137 N/m.

Computation 3.2: **holding the spring at 1.579137 N/m, the effective mass was varied.**

effective mass	resonance (Hz)	inverse square root gives
0.25 times	400.000000	2.000000
1 time	200.000000	1.000000
4 times	100.000000	0.500000

> **Observation 3.3**
>
> **this is the core. The speed is written with mass and spring.Reaching 200 Hz needs 1.579137 N/m, and four times the mass drops it to 100.000000 Hz——neither has anything to do with the rate of commands.**

4. The Separator

Observation 4.1

the separator is whether a command makes each stroke or merely sustains an oscillation.In the first case the ceiling is the nerve's rate; in the second it is the spring and the mass——one phrase, "the muscle drives it", points at two mechanisms.

Observation 4.2

so the way to raise the ceiling changes.On the command side one must fire faster; on the resonance side one lightens the wing or stiffens the thorax——quartering the mass gives 400.000000 Hz.

Observation 4.3

placed beside Papers 326 and 300.Paper 326 showed that the square-cube "law" is an identity——here too the frequency is the square root of a ratio, not a performance.Paper 300 showed that sharing a root is decidable——"the command is fast" and "the resonance is fast" are distinct roots.

Observation 4.4

what is not said.Real insects, the molecular basis of the muscle, aerodynamics and temperature are not treated——what is shown is that changing which side sets the ceiling changes the move.

5. Census and Closing

1. **20 Hz against 200 Hz** (Computation 2.1): **ratio 10.000000.**
2. **5.000000 ms and 50.000000 ms** (Computation 2.1): **the same ratio in time.**
3. **10 strokes between impulses** (Observation 2.2): **not one to one.**
4. **spring constant 1.579137 N/m** (Computation 3.1): **the core; gives 200 Hz.**
5. **1.0 N/m gives 159.154943 Hz** (Computation 3.1): **softer is slower.**
6. **2.5 N/m gives 251.646061 Hz** (Computation 3.1): **stiffer is faster.**

7. **four times the mass: 100.000000 Hz** (Computation 3.2): **inverse square root.**
8. **a quarter: 400.000000 Hz** (Computation 3.2): **lighter is faster.**
9. **the move changes** (Observation 4.2): **rate, or mass and spring.**
10. **stroke by stroke, or sustained** (Observation 4.1): **the separator; Papers 326, 300.**

Closing: **What sets the wingbeat is not the nerve but the spring and the mass.Nerve at 20 Hz against a beat at 200 Hz is 10.000000, and between impulses 50.000000 ms apart the wing moves 10 times——one command per stroke cannot give this speed.With an effective mass of 1.0×10^{-6} kg, 200 Hz needs a spring constant of 1.579137 N/m; four times the mass gives 100.000000 Hz and a quarter gives 400.000000 Hz, while 1.0 N/m gives 159.154943 Hz and 2.5 N/m gives 251.646061 Hz——none of which involves the rate of commands.The separator is whether a command makes each stroke or merely sustains an oscillation, and the way to raise the ceiling changes with it.Placed among the earlier papers——standing beside Paper 326's "identity, not a law", and keeping Paper 300's discipline between command and resonance.To be honest——every value is representative, and neither real insects nor aerodynamics is treated.**

References

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