

Two Devices Working in Opposite Directions Keep One Body the Same

— Against body fluid at **300** mOsm, fresh water pushes water in at **$+7.0673 \times 10^5$** Pa while sea water pulls it out at **-1.6770×10^6** — the magnitudes differ by **2.3729**, matching $(1000 - 300)/(300 - 5)$ — and at the isotonic point of **300** mOsm the difference is exactly zero — [Paper 472]

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— *From thinking to syncing.* —

Abstract

Living things are said to be adapted to their environment. This paper shows that the same end requires devices of opposite sign—in fresh water the fish sheds water, in sea water it drinks. The sign reverses. No new theorem or law is claimed. First, the osmotic pressure of the body fluid is **7.1870×10^5** Pa (Section 2). Second, the difference is **$+7.0673 \times 10^5$** Pa in fresh water and **-1.6770×10^6** in sea water (Section 2). Third, this is the core of the paper. The signs are opposite, as the negative product shows (Section 2). Fourth, the magnitudes differ by **2.3729**, matching the closed form exactly (Section 3). Fifth, at the isotonic point of **300** mOsm the difference is exactly **0.0000000000000000** Pa, and the type flips on either side (Section 3). Sixth, the separator is whether adaptation is one device or two of opposite sign (Section 4). **Keywords:** osmoregulation, fish, osmotic pressure, van 't Hoff equation, gill.

Scope of this paper (scope note): No new theorem or law is claimed—osmotic pressure, van 't Hoff's relation and osmoregulation in fish are all standard. No physiology is designed—chloride cells in the gill, kidney structure and hormonal control are not the subject. The values are representative—300 mOsm for body fluid, 5 for fresh water and 1000 for sea water are representative and vary by species and individual. Ideal solutions are assumed—no activity coefficients; van 't Hoff's relation is used as it stands. Euryhaline species are excluded—the switching mechanism of fish such as salmon that move between both is not the subject. Relation to earlier papers: Paper 471 showed that what must be added is the scarce side, not the plentiful one—there too, the wrong direction achieved nothing. Paper 300 showed that common root and distinct root can be decided—“regulation in fresh water” and “in sea water” are distinct roots by that criterion. Paper 446 showed that a theoretical floor moves with the demand—there too, osmotic pressure sat at the centre of the quantity. What is added is giving the osmotic pressure in three environments, showing the opposite signs by a negative product, giving the ratio of magnitudes as 2.3729 and matching the closed form, confirming an exactly zero difference at the isotonic point, confirming that the type flips on either side of it, and placing the separator at one device versus two of opposite sign.

1. Notation and the Question

Setting: Take the osmotic pressure of a solution of osmolarity c [mOsm/L] from van 't Hoff's relation,

$$\Pi = cRT$$

with c converted to mol/m³. The difference

$$\Delta\Pi = \Pi_{\text{body}} - \Pi_{\text{environment}}$$

drives water into the body when positive and out when negative. Below, $T = 288.15$ K, body fluid 300, fresh water 5 and sea water 1000 mOsm.

Observation 1.1

Living things are said to be adapted to their environment. A fish is built to live in water—as if one solution had been supplied.

Observation 1.2

But “in water” is not one thing. Fresh and sea water sit on opposite sides of the body fluid—they are not the same problem.

Question: By how much, and in which direction.

2. The Signs Are Opposite

Computation 2.1: Take the osmotic pressure at three osmolarities.

Medium	Osmolarity [mOsm]	Osmotic pressure [Pa]
Fresh water	5	1.1978×10^4
Body fluid	300	7.1870×10^5
Sea water	1000	2.3957×10^6

Observation 2.2

Against fresh water the difference is $+7.0673 \times 10^5$ Pa. Positive—the body is the more concentrated, so water comes in.

Observation 2.3

Against sea water it is -1.6770×10^6 Pa. Negative—the sea is the more concentrated, so water goes out.

Observation 2.4

The negative product shows that the directions are opposite. Not merely “both are difficult”—one is too much coming in, the other too much going out: opposite failures.

Observation 2.5

So the remedies are opposite too. In fresh water, copious dilute urine; in sea water, drinking and excreting salt—one device cannot do both.

3. The Ratio Is 2.3729, and the Boundary Is Isotonic

Computation 3.1: Take the ratio of the two magnitudes.

2.3729, the sea water side being larger.

Observation 3.2

It matches the closed form $(1000 - 300)/(300 - 5)$ exactly. $700/295 = 2.372881$ — RT cancels on both sides, leaving only the ratio of concentration differences.

Observation 3.3

The sea water side is 2.37 times the harder. Because the body fluid sits towards fresh water—300 is not the midpoint of 5 and 1000, which would be 502.5.

Computation 3.4: Take the external osmolarity at which the difference vanishes.

300 mOsm, the same as the body fluid, with a difference of exactly **0.0000000000000000** Pa.

Observation 3.5

Just above the isotonic point the type is marine, just below it is freshwater. Negative at 1.01 times, positive at 0.99—confirmed on both sides of the boundary.

Observation 3.6

And at that point regulation costs no work. The difference is zero—which is why brackish waters are favourable.

Observation 3.7

But most fish do not live at the isotonic point. They live in one or the other, always working in one direction—adaptation is continuous work, not rest.

4. The Separator

The separator: is adaptation one device, or two of opposite sign.

Observation 4.1

One device, and only the degree changes. Work harder or work less—a continuous adjustment.

Observation 4.2

Two of opposite sign, and a switch is needed. Wholly different organs for the inward and outward cases—adjusting the degree cannot reach it.

Observation 4.3

These are distinct roots by the criterion of Paper 300. Both are called “osmoregulation”—one the work of shedding water, one of obtaining it.

Observation 4.4

The same shape as Paper 471. There, what had to be added was the scarce side and not the plentiful—here the direction to work in reverses with the environment. In both, the wrong direction achieves nothing.

Observation 4.5

It overlaps Paper 446 as well. There, osmotic pressure set a theoretical floor—here the same quantity sets the direction of an animal’s work. One quantity acting in a machine and in a body alike.

Observation 4.6

So treating “aquatic animals” as one group hides the sign. Both live in water—but they are solving opposite problems.

Observation 4.7

To be honest—ideal solutions were assumed. No activity coefficients, van 't Hoff used as it stands—
 7.0673×10^5 shifts a little, but that the signs are opposite follows from the order of the concentrations alone.

5. Roll Call and Closing

1. Body fluid at 7.1870×10^5 Pa (Computation 2.1): **300 mOsm.**
2. $+7.0673 \times 10^5$ Pa in fresh water (Observation 2.2): **water comes in.**
3. -1.6770×10^6 Pa in sea water (Observation 2.3): **water goes out.**
4. A negative product (Observation 2.4): **the core.**
5. The remedies are opposite (Observation 2.5): **one device cannot do both.**
6. A ratio of **2.3729** (Computation 3.1): **the sea is harder.**
7. Matching the closed form (Observation 3.2): **RT cancels.**
8. Exactly zero at isotonic (Computation 3.4): **no work needed.**
9. The type flips on both sides (Observation 3.5): **a boundary confirmed.**
10. The separator is one device or two (Observation 4.3): **distinct roots by Paper 300.**

Closing: Living things are said to be adapted to their environment—a fish is built to live in water, as if one solution had been supplied. But “in water” is not one thing: fresh and sea water sit on opposite sides of the body fluid, and they are not the same problem. The signs are opposite—body fluid at 300 mOsm gives 7.1870×10^5 Pa; against fresh water the difference is $+7.0673 \times 10^5$ Pa, positive, so water comes in. Against sea water it is -1.6770×10^6 Pa, negative, so water goes out. The negative product shows the directions are opposite: not merely “both are difficult”, but too much coming in against too much going out. So the remedies are opposite too—copious dilute urine in fresh water, drinking and excreting salt in the sea. One device cannot do both. And the difficulty is not symmetric—the two magnitudes differ by **2.3729**, matching $(1000 - 300)/(300 - 5) = 700/295$ exactly, since RT cancels and only the ratio of concentration differences remains. The sea water side is 2.37 times the harder, because the body fluid at 300 sits towards fresh water and not at the midpoint of 502.5. The difference vanishes at an external osmolarity of 300 mOsm, exactly **0.0000000000000000** Pa. Just above that the type is marine and just below it is freshwater, confirmed on both sides. At that point regulation costs no work, which is why brackish waters are favourable. But most fish do not live there: they live in one or the other and work continuously in one direction. Adaptation is work, not rest. One thing separates them—is adaptation one device, or two of opposite sign. One device, and only the degree changes, a continuous adjustment. Two of opposite sign, and a switch is needed, with wholly different organs for the inward and outward cases: adjusting the degree cannot reach it. They are distinct

roots by the criterion of Paper 300, one the work of shedding water and one of obtaining it. It is the same shape as Paper 471, where what had to be added was the scarce side: in both, the wrong direction achieves nothing. It overlaps Paper 446 too, where osmotic pressure set a theoretical floor: one quantity acting in a machine and in a body alike. So treating “aquatic animals” as one group hides the sign—both live in water, but they are solving opposite problems. To be honest—ideal solutions were assumed, with no activity coefficients. 7.0673×10^5 shifts a little, but that the signs are opposite follows from the order of the concentrations alone.

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