

# Critique of the 1977 debate on infra-red 'olfaction' in insects — (Diesendorf vs. P.S.Callahan)

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Poster 22 at the Conference of the Australian Entomological Society,  
at Orange, NSW, Australia — on 30 September 2008.

Ondwelle short-monograph, No. 9

Published online (22 Oct. 2008) by *General Science Journal*, and by *Ondwelle Publications*

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## **Abstract**

During World-War-2, the entomologist P.S.Callahan noticed a remarkable similarity: — The shapes of the various *radar aeriels* closely resembled the various spines etc. on insects. From 1965 onwards, he promoted the idea that insects often detect pheromones via *infra-red* as a scaled-down equivalent of those radar microwaves — with the pheromone-molecules acting as transponders or sites of fluorescence (all invisible to us). This notion was supposedly demolished in a 1977 debate within a single issue of the *International Journal of Insect Morphology and Embryology*.

However a recent detailed review of that debate ([www.wbabin.net/physics/traill7](http://www.wbabin.net/physics/traill7)) has shown up the logic-flaws on both sides of that contest, and hence come to new conclusions based on the same experimental evidence:

(1) That the evidence *does* support Callahan's *main* thesis involving infra-red "beacons".

(2) That it is vital to distinguish between long-range effects (>100 yards, for which there is no credible alternative mechanism anyhow), and short range (where orthodox olfaction is a confounding factor).

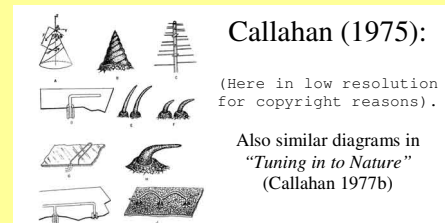
(3) A new interpretation of an anomaly within Callahan's sets of results, suggests that insect brains may sometimes process infra-red signals *directly* via dielectric paths (thus *bypassing the expected action-potentials!*) That could be much more efficient, and might help to explain the surprising memory capacity of bees etc.

(4) It is a matter of public concern that significant interdisciplinary work like Callahan's should be so promptly dismissed on inadequate grounds — even if his own presentation had its failings. Was it all too technical and therefore threatening, or what?

If infra-red signal patterns really do have such pheromone and kairomone roles, that may open up new possibilities for non-chemical arthropod control.

## 1940s: P.S.Callahan noticed — (during W W 2):

- #1 [✓] Radar-aerials have various odd shapes — which closely resemble the spines etc. **on insects!** (In fact he later claimed this is true for all 15 types of dielectric aerial!)  
*This strongly suggests a similar role:*  
*Nature ≈ Human-Design*



## 1960: E.R.Laithwaite (a Professor of Engineering):

- #2 **Q:** Many ♂ moths were known to be locating mates miles away. **But how?**

The key question here

- #3 [✓] Laithwaite showed there are at least 2 quite different navigation methods:  
 (i) Short range = orthodox olfaction (uncertain direction, chasing pheromone itself).  
 (ii) Long-range (>"100 yards") → Clearcut direction, even if wind stops all pheromone from reaching ♂ — so there must be a separate extra mechanism.
- #4 [✓] L. concluded that the long-range effect must depend on infra-red (IR) signals.

*But problematic features:*

- #5 **Q:** In ♂, **which organ might receive** such IR signals?
- #6 [?] L. assumed such reception would be via the antennae.
- #7 [?] If antennae *are* the receivers, then their size implies *long* IR wavelengths (>20 μm)
- #8 **Q:** What is it about the ♀ that **generates the following signals:**  
 (i) "I'm receptive", *and then*  
 (ii) "Sorry, you're too late!"  
 — transmitted too quickly for any diffusion explanation **via carrier-molecules!**
- #9 [?] L. assumed the signals were emitted from the ♀'s body (as if IR glow-worms), and perhaps independent from pheromone emission.
- #10[X] L. overlooked the possibility of fluorescence from pheromones (even though he did discuss attractant fluorescence from water drops — in a rather different context, as an aside!). Cf. #15.

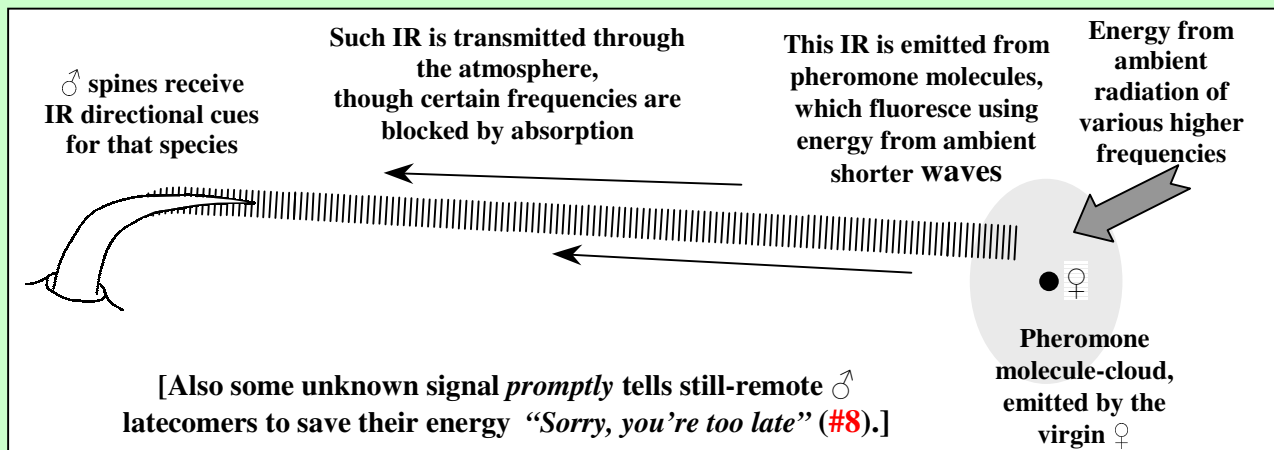
## 1967-1977: Callahan (an Entomologist, then at USDA)

- #11[✓] C. welcomed Laithwaite's support for infra-red (IR).
- #12[✓] Invoking his WW2 spines etc. (#1 above), C. increased the list of receiver-options beyond Laithwaite's one-off antenna-suggestion (#6).
- #13[✓] These alternative smaller aerials implied shorter IR wavelengths (1-20  $\mu\text{m}$ ) — more useful.
- #14[✓] C. showed that the actual spine-lengths tallied only with those IR wavelengths which can travel through the air (without being absorbed by it).
- #15[✓] C. amply demonstrated fluorescence-generated IR, and moths' attraction to it.
- #16[✓] C. argued that the energy-input for this fluorescence came from abundant ambient radiation of higher frequencies — even at night. Of course UV gives a particularly strong effect with its high frequency.
- #17[✓] C. argued the case for “stimulated emission” (Einstein 1917, Townes 1965) as adding to the fluorescence (and as a weak gesture towards laser-like activity).  
[Useful but perhaps non-essential.]
- #18[✓] He also argued that, as the frequency generated collectively by stimulated emission will depend on pheromone concentration, this is therefore a means for detecting gradients.

### *But problematic features:*

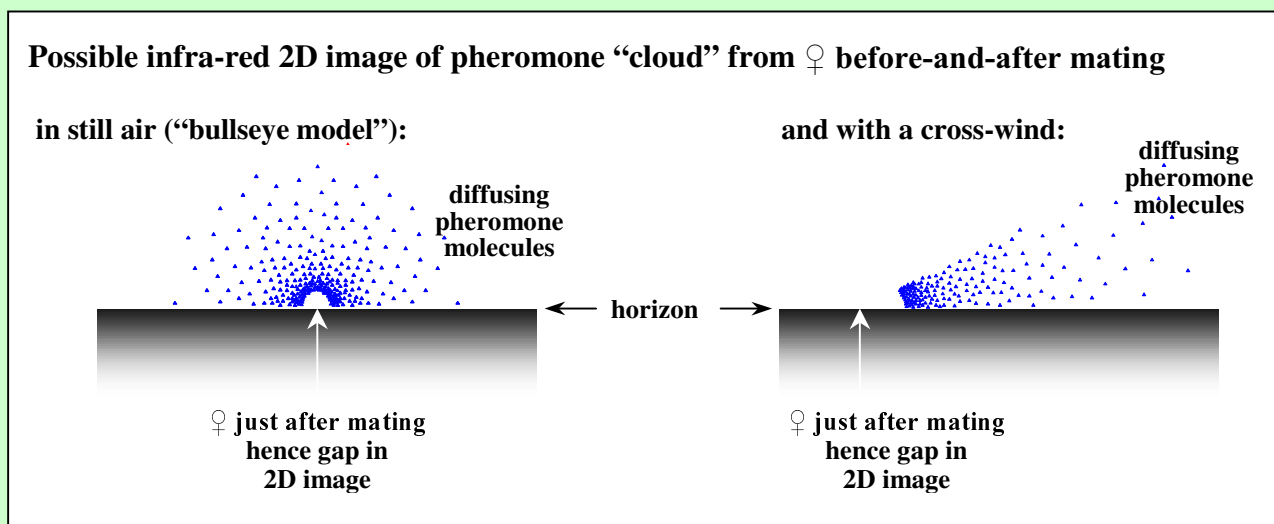
- #19[X] He quite **overlooked** Laithwaite's Long/Short-Range distinction (#3)! — So he tried to impose his IR ideas onto all-or-most Short-Range effects. Not totally unreasonable, but on shaky ground — and irrelevant to the Long-Range case.
- #20[X] He saw the stimulated-emission gradient (#18) as *the* key navigational mechanism — despite Laithwaite's convincing argument against gradients for Long-Range. Indeed C. even asserted that L.'s experimental evidence must be wrong!!
- #21[X] C. made several “amateurish” mistakes in his physics details, (e.g. units, terminology, etc...), not critical in themselves, but prejudicial to his case.
- #22[?] **Anomalous finding:** C's experiments showed *behavioural* response to IR, but he was unable to find any intervening *action-potential* in the nerves! (And yet there was no such problem for *visible* light!) — Also see #32 below, and the “conclusions”.

## The Basic Logical Solution to the Cited Experimental Findings:



### Some possible enhancements to that basic solution:

- #23 [?] **Arrays** of spines etc. Callahan pointed to the need for whole arrays of aerials (as in Radio-Astronomy), especially for enhancing direction-finding and image-formation. Clearly the spines on insects are available as arrays.
- #24 [?]\* The “Sorry, you’re too late” message (#8) may be a separate “anti-pheromone” molecule-type and its IR emissions. — **Or:**
- #25 [?]\* This information may come from the shape of the IR image if it can be “seen” in 2D. Thus:



### \* Post-conference critique about “cancellation” of the pheromone signal:

If we see this prompt cancellation-effect as mysterious, it is probably because we are still *assuming a key role for diffusion* — that very slow process — at least in setting up an identifiable “cloud shape” (#25 above), or perhaps as something more orthodox. **However**, if fluorescence *is* the main mechanism, this will probably be occurring mainly where the pheromone-cloud is most concentrated — *very close to its ♀ source* (though not actually at the source herself as Laithwaite assumed). Hence when the female stops emitting the pheromone, that local high-concentration will fairly quickly disperse, and the most effective part of the IR-emission would also cease. Thus the above suggestions #24 and #25 are probably both superfluous, though they might still offer contributory cues for some species.

RRT (21 October 2008)

## **The 1977 debate between Diesendorf and Callahan:**

This debate was a mess; with political point-scoring, and no editorial.

Callahan's shortcomings (incl.#19-#22) were paraded, while his-and-Laithwaite's achievements were brushed aside; so he was deemed to have lost the "battle". Hence the whole idea of IR communication was dropped, despite the unresolved issues.

- #26[X] Neither C nor D mentioned Laithwaite's distinction between Short and Long Range!!!!
- #27[X] So both got bogged down on Short-Range issues : — (arcane unresolved topics such as: signal-chopping,  $d \ll \lambda$  in bipole theory, and orthodox olfaction-mechanisms — all being of dubious relevance).
- #28[X] Both wasted effort discussing unlikely alternative energy sources (such as "rubbing", and "black-body radiation").
- #29[X] Both wasted effort discussing possible optical-coherence of the signals (probably irrelevant!) — largely because Callahan tended to confuse "coherence" with the vital "monochronicity"!!!!
- #30[X] Likewise they argued unproductively because Callahan had not made it clear what he meant by "maser-like". Was he concerned with production of:  
 → Coherence? (irrelevant, #29)? — or —  
 → Amplification? (non-basic, #17)? — or —  
 → Gradient-measure? (Short-range, and not necessarily basic, #18)?  
 And with no efficient reflectors, the effect could only be relatively weak anyhow.
- #31[?] D objected that thermal-IR background would drown those signals with wavelengths  $> 4 \mu\text{m}$ ; but that need not apply fully if the signals were narrow-band and "loud" enough.
- #32[?] Anomaly of the missing **action-potential** (#22) after IR stimulation, while still getting a behavioural response. — Diesendorf saw this as a fatal flaw! Callahan didn't!  
 One logical resolution is to postulate a different extra peri-neural transmission-mode — see the "Conclusions".

### **Further information, including extra references:**

<http://www.ondwelle.com/OSM03.pdf> (This topic);  
<http://www.ondwelle.com> (Related works)

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## **Conclusions:**

- ♣ Laithwaite was right in believing there are **at least two odour-detecting mechanisms**, and that the one for **Long-Range involves infra-red**.
  - ♣ Callahan was right in identifying many insect **sensillae as the aerials for infra-red signals**; but he exposed himself to criticism by careless presentation, and inadequate self-defence.
  - ♣ Diesendorf identified some of Callahan's failings, but overlooked the possibility of important truths hidden under the confusion. He also virtually ignored Laithwaite.
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- There are three plausible explanations for the mysteriously rapid “anti-pheromone” (“*too late*”) signal:
    - (i) a hypothetical “antidote” system;           (ii) the promptly altered “bullseye-or-wedge” geometry of the IR-emitting pheromone-cloud; — &/or more likely [*added post-conference*]:
    - (iii) most of the effective fluorescence will occur fairly close to the female, and hence will soon dissipate when she stops producing the pheromone.
  - The “missing **action-potential**” (#22, #32) might be explained if we accept that axons sometimes serve as optic fibres for infra-red, as was postulated independently for mammals (Traill, 1978 Part B).
- 
- ▶ The scientific community was remiss in allowing this topic to be buried prematurely — and that is a matter of some social concern.
  - ▶ This avenue could well open up new possibilities for arthropod-control.

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