Appendix to R.R.Traill's
"How Popperisn positivism killed a good-but-poorly-presented theory
— Insect Communication by Infrared"

A more readable version of its Table 4.1:

Catalogue and summary of **evidence-and-assertions** relating to the 1977 debate between M.Diesendorf and P.S.Callahan

#	ty	mn	Description	sub	ext	nr	far	#2	References and sources
2	H	<ch	We should distinguish 3 range-zones for any possible chemical olfaction: (A) **Contact** mol/ receptor; (B) "**Dipole-near**" (<50nm?); (C) "**Dipole-far**" (>50nm)			9		2	from standard Dipole Theory
7	H	ky2	(Almost) all insect "knobs" are lock&key contact-detectors for scent-molecules			9=		7	Kettlewell; /*\326c2"fit"
8	H	ky1	Some insect "knobs" are lock&key contact-detectors for scent-molecules			9=		8	
9	H	ky0	(Almost) no insect "knobs" are lock&key contact-detectors for scent-molecules			9=		9	
10	E	ky=	The immune system uses molecular lock&key contact-detectors for identification; (xyz)			9		10	well known
11	H	sAx	Any contact(A)-discrimination* between scents depends on molecule geometry (*xyz*) *See #2 and its nearness-categories A,B,C			9		11	
12	H	sBx	Some dipole-near(B)-discrimination* between scents depends on molecule geometry (*xyz*) *See #2 and its nearness-categories A,B,C			9		12	**(i)** Short-range only
13	H	sBt	Some dipole-near(B)-discriminatn between scents depends on electromagnetic *time-patterns* from the scent molecules (*t*)			9		13	(not discussed further here)
14	H	sCt	Any dipole-far(C)-discrimination between scents depends on electromagnetic *time-patterns* from the scent molecules (*t*)			9		14	
20	H	el:	Insect cuticle is capable of forming electrets			5		20	/*\p319
23	E	ecg	*E.coli* uses a *d/dt* gradient to find a **near** target			9		23	Alberts et al,(1983), p758
33	A	d>>	For "far" dipole-range ($d>\lambda$), phase patterns are const with respect to *time*, so d "makes no difference"			9		33	/C3\115.1
34	A	d<t	For "near" dipole-range ($d<<\lambda$), phase patterns are **different**, *NOT* absent as Diesendorf, /D2\109.3 implies			9		34	NEW
44	E	dir	Wolf Spider points spines toward target			9		44	/*\p325, fig.14
46	E	irr	Moths have irridescence etc for IR frequencies			9		46	/*\p330
49	E	qm0	Some scent-atom/molec will start with excitation energy when they leave target [but ephemeral]			9		49	/*\p333c2.9
52	E	dk~	Wolf Spider finds prey or mate in total darkness (with respect to visible light), & without any antennae			9		52	/*\p326, /t\p133
57	A	# mm	Irrelevant here: how *mammalian* olfaction operates			5		57	/*\p341c2.3
59	E	fla	Moths follow pheromone long-range, but then candle-flame at short-range			9		59	/*\p343c1.4, (Fabre,1913; Shorey&Gaston, 1965)
61	A	flc	"radiation-pumping" of molecules can mislead closeup (especially near Humans), so alternatives could help			9		61	
62	E	fld	Despite the case for closeup homing via "2 & 3", insects *are* still misled — as if using "1" alone			9		62	Fabre
63	H	fl2	Use of close-up homing-method 2: "normal" incoherent-light-or-IR vision —			9		63	common assumption
64	H	fl3	Use of close-up homing-method 3: traditional olfaction via concentration-gradient (perhaps via some roundabout effect)			9		64	/t\p187
65	A	cg1	Insect's sensing of concentration-gradient is by d/dx: comparing 2+ sensors simultaneously;			9		65	common assumption
66	A	cg2	Insect's sensing of concentration-gradient is by d/dt: remembering + retesting — like chemotaxis in Escherichia coli bacteria			9		66	Alberts *et al* (1983), pp575-579
67	A	cg3	Insect's sensing of concentration is by the frequency of its nearby stimulated emission;			9		67	/t\p187,fig.20
79	E	mir	Mirror-walls→ increased mating-rate;			9		79	/*\p343c2, /t\p152
80	E	leg	RatMites detect IR (incl. specif. freqs) via setae spines on front leg-tarsals			9		80	Bruce (1971 jul)
82	E	mol	Enantiomeric (opt.isomer) forms of scent molecs → different responses after conditioning to one of them — in locust & bee — *cit./D2\p108.4 (#logic!)*			9		82	Kafka+3(1973)[JCompPhio87,277;+(1971?)]
83	E A	odi	Circumstantial evidence favouring contact-mechanisms for odour detection in insects, eg template "lock-&-key" fit for specific molecules			9		83	Kaissling (1971)
84	E A	odm	Evidence (incl elimination) favouring contact-mechanisms for odour detection in *mammals*, eg template "lock-&-key" fit for specific molecules			9		84	Altner&Prillinger (1980), Davies (1971), Beets(1971)

#	ty	mn	Description	sub	ext	nr	far	#2	References
3	H	ae2	All (or nearly all) insect innervated "knobs" & pits are electromagnetic aerials (capable of *time-pattern* discrimination, like TV)	b+		5=	9=	3	Callahan
4	H	ae1	Some insect innervated "knobs" & pits are electromagnetic aerials (capable of *time-pattern* discrimination, like TV)	b+		5=	9=	4	Callahan
6	F	ae=	TV, radio, radar, etc have "knobs" which serve as electromagnetic aerials capable of *time-pattern* discrimination	b		5	9	6	well known
15	A	bod	Some (discriminable) IR signals come from the target's body heat; (≈29)	a.		5	5	15	Laithwaite (1960 Jul); critic/0\34.7
16	H	bwi	Any "bod"(15) IR signal is modulated (made discriminable) by *time*-code of wing-flaps etc; [*t*-code]	a.		5	5	16	Callahan (1965a, ...)
17	H	ant	Whole antenna could theoretically act as an aerial for FIR (20-200μm);	b		9	9	17	Laithwaite (1960 Jul)
18	F	+++	Whole antenna is like a military "fishbone" aerial array for radar;	b		5	9	18	Laithwaite (1960 Jul)
19	E	off	Signal "switched off" soon after mating;	a			9	19	Laithwaite (1960 Jul)
22	E	fab	**far** detection is possible (when no scent molecules could be reaching the receptor)	a			9	22	Fabre, Laithwaite
24	E	pit	Grant's pits have geometry compatible with their being electromagnetic aerials;	b+		9	9	24	Grant (1949)
25	E	pir	Grant's pits: size is such that, if aerials, they are appropriate for IR reception	b+		9	9	25	Grant (1949)
26	A	pi=	Grant's pits seen as aerial types	b+		9	9	26	/*\p138, Grant (1949)
27	H	phm	Some (discriminable) IR signals come from pheromone molecules;	a+		9	9	27	Diesendorf:/D0\34.7
28	A	+sp	Energy for pheromone IR signals can come from mere black-body spontaneous emissn; [*denied by Diesendorf*]	a!		9	9	28	/D0\42-3
29	A	+bo	Energy-supply for any pheromone IR signals must be adequate & sustainable (≈15)	a.		9	9	29	/D0\44+
30	A	+ru	Some Energy for pheromone IR signals from rubbing;	c		5	9	30	/C3\p113.38: Q: /D2?\107.1
31	F	+fl	Some Energy for pheromone IR signals via fluorescence ex blue/UV/...; ≈60	a:		9	9	31	/C3\p113.38: Q: /D2?\107.1
32	A	peg	Grant's "peg" = pit-sensilla, well-placed to "fire" dendrite; → action-potential spike (or TEM mode fibre-optic signal! — NEW)	b		9	9	32	Diesendorf:/D0\36.8, Grant, NEW
36	E	rub	Insect is "constantly rubbing" especially in humid conditions [This "must have some meaning"]	c		9	8	36	/C3\p112.2
37	E	vib	Oft-seen "vibrations" of antennae [These "must have some meaning"]	c		9	8	37	/C3\112.2 — + (C/*\321c1> 1965b[AnESAm58:159-69])
38	A	oft	Oft-seen behaviour or bio-structures must have significance (else eliminated by evolution)	c		9	8	38	/C3\p112.2
39	H	spi	Assume any IR reception → response via action-potential "spike" "[A]"	b^		9	9	39	physiologists' standard assumption
40	E	sp#	Seems: No reported direct evidence that *IR*→action potential spikes —— [yet Callahan did find such spikes for *visible* light ("gating": see "spL" (#94)).]	b^		5	5	40	Callahan(1968)p1425-; Hsiao('72), Diesendorf
41	F	key	Consistent phase-control could serve as callsign ID, different from noise & other signals	a`		9	9	41	/*\p343c1.2 (implied)
42	E	ge1	tapering & other geometry of macro dielectric aerial → match impedance free space [engineering] ≈43	b.		9	9	42	/*\p323c2
43	E	ge2	tapering & other geometry of (micro) dielectric insect spines ↔ macro dielectric ≈42	b.		9	9	43	/*\
45	E	win	Atmos windows for IR match corneal lens transmission windows	d/			9	45	/*\p338-9
47	E	amp	"Maser-like" Stimulated-emission can → amplification	a^		9	9	47	/*\p331
48	E	tow	Maser-like Stimulated-emission is very common in IR → amplification	a^		9	9	48	/*\p333c1; Townes(1965)[Sci149]p837
50	F	co/	optical "coherence" can be partial	a`		9	9	50	/*\p334c2.9
51	F	co^	partial "coherence" can, in principle, suffice to override random background noise	a`		9	9	51	/*\p334c2.9
53	A	drx	Molecules do act as dipole aerials — (Townes, 1965; Drexhage, 1970)	d:		9	9	53	/*\p335c1.7; Drexhage (1970)
54	A	dco	Human retinal cones may well serve as dipole aerials — [eye oscillation — NB]	d:		9	9	54	Myers (1965) /*\p342c2.4
56	E	eyI	Corneal lens is an "eye" for incoherent IR — & better than the bee-eye (for visible & UV)	di		9	5	56	/*\p338c2
60	H	flb	IR attraction operates via "radiation-pumped molecules" — (method "1": RRT) ≈31	a:		9	9	60	/*\p343c2.2
68	H	cg#	Frequency of the target-female's pheromone IR emission indicates its concentration, hence how near it is. Could aid targeting.	a		5	5	68	/t\p189
69	F	c~3	The concentration of a scent affects the frequency of its stimulated emission;	a		9	9	69	/*\p175-7, 187, **211**
70	A	t&e	Spines can have dual roles: tactile AND electromagnetic	b		9	8	70	/*\p342c2.8
71	F	ir^	Ambient IR remains abundant at night	a		9	9	71	/*\p344 (eg)
72	A	irS	Ambient (incoherent?) **short**-wave-IR offers source of pumping-energy	a		9	9	72	Callahan
73	H	irL	Ambient (incoherent) **longer**-wave-IR constitutes **noise** which will kill the needed signals. [NEG]	a`		9	9	73	Diesendorf
74	E	irH	Rising Relative-Humidity increasingly kills off IR signals	d/		9	9	74	/*\p336
75	E	ir#	At High Relative-Humidity, insect mating etc fails to occur	d/		9	9	75	/*\p339c2.4
76	E	ir/	At High Relative-Humidity, arthropods spend much time wiping antennae etc (even to exhaustion)	d/		9	9	76	/*\p339c2.8

(ii) Long-range; (may apply to short-range also)

#	ty	mn	Description	sub	ext	nr	far	#2	References
78	E	u&s	Strong interaction effects increase the mating-rate, [eg. UV *PLUS* pheromone-scent — see "u:=" (95)];	a+		9	9	78	/t\p149-162 (e.g.)
81	F	las	VisibleLight: Laser efficiency in producing action-potential "spikes" in nerves >> mere mixed-phase monochrome efficiency (by 42×),	a^		5	5	81	Callahan (1968)[ApplOpt7:1425-30] Bruce(1971)[AnESAm64:925-31]
86	H	sp~	IR reception can be conveyed direct to the dendrite **as** natural IR, (without needing any "spike"); — then conducted on dendrite surface [RRT] **"[R]"**	b^		9	9	86	NEW; Schriever(1920)
88	E	res	IR → measurable response (whatever the route)	di		5	9	88	Callahan
89	E	nat	Natural coherence (phase correlation), eg for expts in Fresnel's day	a`		9	9	89	NEW (in this context)
90	A	dst	Geometry, frequency, & phase distributions (or cloud emission) — "bullseye" model	a+			9	90	NEW
91	F	cld	Female moths & food crops → pheromones or other chem "odours" — but which may also have significant IR-optical properties	a+		5	9	91	Callahan etc
92	F	wvg	Time-pattern information capture from macro-waveguide → TV demodulation etc	b			9	92	well known
93	F	mye	Time-pattern information capture from myelin segment → molecular demodulation?	b			9	93	Traill (2005b)
94	F	spL	Callahan did find action-potl. spikes for *visible* light ("gating" the IR reception throughout the antenna). — [but apparently no spikes from IR itself]	b		5	5	94	Callahan(1968)p1425-; Hsiao('72), Diesendorf
95	H	u:=	UV *PLUS* pheromone-scent → IR through fluorescence; [& this IR is what increases the mating rate]	a+		9	9	95	/t\p149-162 (e.g.)

#	ty	mn	Description	sub	ext	nr	far	#2	References
77	H	coh	For Callahan (/*\p316+) (& perhaps Groner, his source?), "coherence" actually means *"consistent phase-control"*	D				77	NEW
35	A	d<x	Diesendorf /D4\125.2 "then...molecular structure"[xyz]; anyhow "sensilla shapes become irrelevant to...olfaction" cf.array	F			?	35	NEW: see Amoore (1971), etc.
21	H	elt	Electrets might serve as memory elements (& collectively: like a Lamarckian tape-recorder)	L		-	-	21	/*\p341c2.6
85	A	emp	Proof of C's ae(1 or 2 — idea of A→IR→Z) requires positively demonstrating IR→Z in absence of A. [Empirical insistence]	M		-	-	85	/D2\p106.6, 106.7
1	H	<yd	We should distinguish Laithwaite's 2 target-range-zones: near (<100yds), far (>=100yds)	M		*	*	1	Laithwaite (1960)
55	E	wHi	High relative.humidity blocks IR Duplicates irH (74) qv	X				55	/*\p336
87	E	lip	IR signals (as such) may travel along dendrites, thus obviating any need for Action potential spikes (& explaining why C didn't find them); Dupl 86	X				87	NEW
58	A	#zz	Irrelevant here: What happens when directly-destructive intensities are used?	X		5	5	58	/*\p341c2.4

(iii) Metascience, remarks & dupl^n. (some are tacitly used in the text here)

Main References
and their abbreviations

Callahan, P.S. (1967) "Insect molecular bioelectronics: A theoretical and experimental study of insect sensillae as tubular waveguides, with particular emphasis on their dielectric and thermoelectret properties". *Miscellaneous Publications of the Entomological Society of America* **5**(7), 313-347. — "**/∗**"

Callahan, P.S. (1975) "Insect antennae with special reference to the mechanism of scent detection and the evolution of the sensilla" *International J. Insect Morphol. and Embryol.* **4**(5), 381-430. — "**/C1**"

Callahan, P.S. (1977a) "Comments on Mark Diesendorf's critique of my review paper" *International J. Insect Morphol. and Embryol.* **6**(2), 111-122. — "**/C3**"

Callahan, P.S. (1977b) *Tuning in to Nature*. Routledge & Kegan Paul: London. — "**/t**"

Diesendorf, M. (1977a) "Insect sensilla as dielectric aerials for scent detection? Comments on a review by P.S.Callahan" *International J. Insect Morphol. and Embryol.* **6**(2), 105-109. — "**/D2**"

Diesendorf, M. (1977b) "The 'dielectric waveguide theory' of insect olfaction: a reply to P.S.Callahan" *International J. Insect Morphol. and Embryol.* **6**(2), 123-126. — "**/D4**"

Diesendorf, M., G.Stange, and A.W.Snyder (1974) "A theoretical investigation of radiation mechanisms of insect chemoreception" *Proceedings of the Royal Society of London, B*, **185**, 33-49. — "**/D0**"

Laithwaite, E.R. (1960) "Radiation Theory for the Assembling of Moths". *The Entomologist*. **93**(1165 June), 113-7, and **93**(1166 July), 133-7, +plate.

The Same Table
re-sorted back into numerical order of its "#" labels
(with a loose attempt to group like with like)

#	ty	mn	Description	sub	ext	nr	far	#2	References and sources
1	H	<yd	We should distinguish Laithwaite's 2 target-range-zones: near (<100yds), far (>=100yds)		M	*	*	1	Laithwaite (1960)
2	H	<ch	We should distinguish 3 range-zones for any possible chemical olfaction: (A) **Contact** mol/ receptor; (B) "**Dipole-near**" (<50nm?); (C) "**Dipole-far**" (>50nm)			9		2	from standard Dipole Theory
3	H	ae2	All (or nearly all) insect innervated "knobs" & pits are electromagnetic aerials (capable of *time-pattern* discrimination, like TV)	b+		5=	9=	3	Callahan
4	H	ae1	Some insect innervated "knobs" & pits are electromagnetic aerials (capable of *time-pattern* discrimination, like TV)	b+		5=	9=	4	Callahan
6	F	ae=	TV, radio, radar, etc have "knobs" which serve as electromagnetic aerials capable of *time-pattern* discrimination	b		5	9	6	well known
7	H	ky2	(Almost) all insect "knobs" are lock&key contact-detectors for scent-molecules			9=		7	Kettlewell; /*\326c2"fit"
8	H	ky1	Some insect "knobs" are lock&key contact-detectors for scent-molecules			9=		8	
9	H	ky0	(Almost) no insect "knobs" are lock&key contact-detectors for scent-molecules			9=		9	
10	E	ky=	The immune system uses molecular lock&key contact-detectors for identification; (xyz)			9		10	well known
11	H	sAx	Any contact(A)-discrimination* between scents depends on molecule geometry (*xyz*) *See #2 and its nearness-categories A,B,C			9		11	
12	H	sBx	Some dipole-near(B)-discrimination* between scents depends on molecule geometry (*xyz*) *See #2 and its nearness-categories A,B,C			9		12	
13	H	sBt	Some dipole-near(B)-discriminatn between scents depends on electromagnetic *time-patterns* from the scent molecules (*t*)			9		13	
14	H	sCt	Any dipole-far(C)-discrimination between scents depends on electromagnetic *time-patterns* from the scent molecules (*t*)			9		14	
15	A	bod	Some (discriminable) IR signals come from the target's body heat; (≈29)	a.		5	5	15	Laithwaite (1960 Jul); critic/0\34.7
16	H	bwi	Any "bod"(15) IR signal is modulated (made discriminable) by *time*-code of wing-flaps etc; [*t*-code]	a.		5	5	16	Callahan (1965a, ...)
17	H	ant	Whole antenna could theoretically act as an aerial for FIR (20-200μm);	b		9	9	17	Laithwaite (1960 Jul)
18	F	+++	Whole antenna is like a military "fishbone" aerial array for radar;	b		5	9	18	Laithwaite (1960 Jul)
19	E	off	Signal "switched off" soon after mating;	a			9	19	Laithwaite (1960 Jul)
20	H	el:	Insect cuticle is capable of forming electrets				5	20	/*\p319
21	H	elt	Electrets might serve as memory elements (& collectively: like a Lamarckian tape-recorder)		L	-	-	21	/*\p341c2.6
22	E	fab	**far** detection is possible (when no scent molecules could be reaching the receptor)	a			9	22	Fabre, Laithwaite
23	E	ecg	*E.coli* uses a *d/dt* gradient to find a **near** target			9		23	Alberts et al,(1983), p758
24	E	pit	Grant's pits have geometry compatible with their being electromagnetic aerials;	b+		9	9	24	Grant (1949)
25	E	pir	Grant's pits: size is such that, if aerials, they are appropriate for IR reception	b+		9	9	25	Grant (1949)
26	A	pi=	Grant's pits seen as aerial types	b+		9	9	26	/*\p138, Grant (1949)
27	H	phm	Some (discriminable) IR signals come from pheremone molecules;	a+		9	9	27	Diesendorf:/D0\34.7
28	A	+sp	Energy for pheremone IR signals can come from mere black-body spontaneous emissn; [*denied by Diesendorf*]	a!		9	9	28	/D0\42-3
29	A	+bo	Energy-supply for any pheremone IR signals must be adequate & sustainable (≈15)	a.		9	9	29	/D0\44+
30	A	+ru	Some Energy for pheremone IR signals from rubbing;	c		5	9	30	/C3\p113.38: Q: /D2?\107.1
31	F	+fl	Some Energy for pheremone IR signals via fluorescence ex blue/UV/...; ≈60	a:		9	9	31	/C3\p113.38: Q: /D2?\107.1
32	A	peg	Grant's "peg" = pit-sensilla, well-placed to "fire" dendrite; → action-potential spike (or TEM mode fibre-optic signal! — NEW)	b		9	9	32	Diesendorf:/D0\36.8, Grant, NEW
33	A	d>>	For "far" dipole-range (d>λ), phase patterns are const <u>with respect to *time*</u>, so *d* "makes no difference"			9		33	**/C3**\115.1
34	A	d<t	For "near" dipole-range (d<<λ), phase patterns are **different**, *NOT absent* as Diesendorf, /D2\109.3 implies			9		34	NEW
35	A	d<x	Diesendorf /D4\125.2 "then...<u>molecular structure</u>"[xyz]; anyhow "<u>sensilla shapes</u> become irrelevant to...olfaction" cf.array		F		?	35	NEW: see Amoore (1971), etc.
36	E	rub	Insect is "constantly rubbing" especially in humid conditions [This "must have some meaning"]	c		9	8	36	/C3\p112.2
37	E	vib	Oft-seen "vibrations" of antennae [These "must have some meaning"]	c		9	8	37	/C3\p112.2 — + (C/*\321c1> 1965b[AnESAm58:159-69])
38	A	oft	Oft-seen behaviour or bio-structures must have significance (else eliminated by evolution)	c		9	8	38	/C3\p112.2

39	H	spi	Assume any IR reception → response via action-potential "spike" **"[A]"**	b^	9	9	39	physiologists' standard assumption
40	E	sp#	Seems: No reported direct evidence that _IR_→action potential spikes —— [yet Callahan did find such spikes for _visible_ light ("gating": see "spL" (#94)).]	b^	5	5	40	Callahan(1968)p1425-; Hsiao('72), Diesendorf
41	F	key	Consistent phase-control could serve as callsign ID, different from noise & other signals	a`	9	9	41	/*\p343c1.2 (implied)
42	E	ge1	tapering & other geometry of macro dielectric aerial → match impedance free space [engineering] ≈43	b.	9	9	42	/*\p323c2
43	E	ge2	tapering & other geometry of (micro) dielectric insect spines ↔ macro dielectric ≈42	b.	9	9	43	/*\
44	E	dir	Wolf Spider points spines toward target			9	44	/*\p325, fig.14
45	E	win	Atmos windows for IR match corneal lens transmission windows	d/		9	45	/*\p338-9
46	E	irr	Moths have irridescence etc for IR frequencies			9	46	/*\p330
47	E	amp	"Maser-like" Stimulated-emission can → amplification	a^	9	9	47	/*\p331
48	E	tow	Maser-like Stimulated-emission is very common in IR → amplification	a^	9	9	48	/*\p333c1; Townes(1965)[Sci149]p837
49	E	qm0	Some scent-atom/molec will start with excitation energy when they leave target [but ephemeral]			9	49	/*\p333c2.9
50	F	co/	optical "coherence" can be partial	a`	9	9	50	/*\p334c2.9
51	F	co^	partial "coherence" can, in principle, suffice to override random background noise	a`	9	9	51	/*\p334c2.9
52	E	dk~	Wolf Spider finds prey or mate in total darkness (with respect to visible light), & without any antennae			9	52	/*\p326, /t\p133
53	A	drx	Molecules do act as dipole aerials — (Townes, 1965; Drexhage, 1970)	d:	9	9	53	/*\p335c1.7; Drexhage (1970)
54	A	dco	Human retinal cones may well serve as dipole aerials — [eye oscillation — NB]	d:	9	9	54	Myers (1965) /*\p342c2.4
55	E	wHi	High relative.humidity blocks IR Duplicates irH (74) qv		X		55	/*\p336
56	E	eyI	Corneal lens is an "eye" for incoherent IR — & better than the bee-eye (for visible & UV)	di	9	5	56	/*\p338c2
57	A	#mm	Irrelevant here: how _mammalian_ olfaction operates			5	57	/*\p341c2.3
58	A	#zz	Irrelevant here: What happens when directly-destructive intensities are used?	X	5	5	58	/*\p341c2.4
59	E	fla	Moths follow pheromone long-range, but then candle-flame at short-range			9	59	/*\p343c1.4, (Fabre,1913; Shorey&Gaston, 1965)
60	H	flb	IR attraction operates via "radiation-pumped molecules" — (method "1": $_{RRT}$) ≈31	a:	9	9	60	/*\p343c2.2
61	A	flc	"radiation-pumping" of molecules can mislead closeup (especially near Humans), so alternatives could help			9	61	
62	E	fld	Despite the case for closeup homing via "2 & 3", insects _are_ still misled — as if using "1" alone			9	62	Fabre
63	H	fl2	Use of close-up homing-method 2: "normal" incoherent-light-or-IR vision —			9	63	common assumption
64	H	fl3	Use of close-up homing-method 3: traditional olfaction via concentration-gradient (perhaps via some roundabout effect)			9	64	/t\p187
65	A	cg1	Insect's sensing of concentration-gradient is by d/dx: comparing 2+ sensors simultaneously;			9	65	common assumption
66	A	cg2	Insect's sensing of concentration-gradient is by d/dt: remembering + retesting — like chemotaxis in Escherichia coli bacteria			9	66	Alberts _et al_ (1983), pp575-579
67	A	cg3	Insect's sensing of concentration is by the frequency of its nearby stimulated emission;			9	67	/t\p187,fig.20
68	H	cg#	Frequency of the target-female's pheromone IR emission indicates its concentration, hence how near it is. Could aid targeting.	a	5	5	68	/t\p189
69	F	c~3	The concentration of a scent affects the frequency of its stimulated emission;	a	9	9	69	/*\p175-7, 187, **211**
70	A	t&e	Spines can have dual roles: tactile AND electromagnetic	b	9	8	70	/*\p342c2.8
71	F	ir^	Ambient IR remains abundant at night	a	9	9	71	/*\p344 (eg)
72	A	irS	Ambient (incoherent?) **short**-wave-IR offers source of pumping-energy	a	9	9	72	Callahan
73	H	irL	Ambient (incoherent) **longer**-wave-IR constitutes **noise** which will kill the needed signals. [NEG]	a`	9	9	73	Diesendorf
74	E	irH	Rising Relative-Humidity increasingly kills off IR signals	d/	9	9	74	/*\p336
75	E	ir#	At High Relative-Humidity, insect mating etc fails to occur	d/	9	9	75	/*\p339c2.4
76	E	ir/	At High Relative-Humidity, arthropods spend much time wiping antennae etc (even to exhaustion)	d/	9	9	76	/*\p339c2.8
77	H	coh	For Callahan (/*\p316+) (& perhaps Groner, his source?), "coherence" actually means _"consistent phase-control"_		D		77	NEW
78	E	u&s	Strong interaction effects increase the mating-rate, [eg. UV _PLUS_ pheromone-scent — see "u:=" (95)];	a+	9	9	78	/t\p149-162 (e.g.)
79	E	mir	Mirror-walls→ increased mating-rate;			9	79	/*\p343c2, /t\p152
80	E	leg	RatMites detect IR (incl. specif. freqs) via setae spines on front leg-tarsals			9	80	Bruce (1971 jul)

#	ty	mn	Description	sub	ext	nr	far	#2	References and sources
81	F	las	VisibleLight: Laser efficiency in producing action-potential "spikes" in nerves >> mere mixed-phase monochrome efficiency (by 42×),	a^		5	5	81	Callahan (1968)[ApplOpt7:1425-30] Bruce(1971)[AnESAm64:925-31]
82	E	mol	Enantiomeric (opt.isomer) forms of scent molecs → different responses after conditioning to one of them — in locust & bee — cit./D2\p108.4 (#logic!)			9		82	Kafka+3(1973)[JCompPhio87,277;+(1971?)]
83	E A	odi	Circumstantial evidence favouring contact-mechanisms for odour detection in insects, eg template "lock-&-key" fit for specific molecules			9		83	Kaissling (1971)
84	E A	odm	Evidence (incl elimination) favouring contact-mechanisms for odour detection in *mammals*, eg template "lock-&-key" fit for specific molecules			9		84	Altner&Prillinger (1980), Davies (1971), Beets(1971)
85	A	emp	Proof of C's ae(1 or 2 — idea of A→IR→Z) requires positively demonstrating IR→Z in absence of A. [Empirical insistence]	M	-	-		85	/D2\p106.6, 106.7
86	H	sp~	IR reception can be conveyed direct to the dendrite **as** natural IR, (without needing any "spike"); — then conducted on dendrite surface [RRT] **"[R]"**	b^		9	9	86	NEW; Schriever(1920)
87	E	lip	IR signals (as such) may travel along dendrites, thus obviating any need for Action potential spikes (& explaining why C didn't find them); Dupl 86	X				87	NEW
88	E	res	IR → measurable response (whatever the route)	di		5	9	88	Callahan
89	E	nat	Natural coherence (phase correlation), eg for expts in Fresnel's day	a`		9	9	89	NEW (in this context)
90	A	dst	Geometry, frequency, & phase distributions (or cloud emission) — "bullseye" model	a+			9	90	NEW
91	F	cld	Female moths & food crops → pheromones or other chem "odours" — but which may also have significant IR-optical properties	a+		5	9	91	Callahan etc
92	F	wvg	Time-pattern information capture from macro-waveguide → TV demodulation etc	b			9	92	well known
93	F	mye	Time-pattern information capture from myelin segment → molecular demodulation?	b			9	93	Traill (2005b)
94	F	spL	Callahan did find action-potl. spikes for *visible* light ("gating" the IR reception throughout the antenna). — [but apparently no spikes from IR itself]	b		5	5	94	Callahan(1968)p1425-; Hsiao('72), Diesendorf
95	H	u:=	UV *PLUS* pheromone-scent → IR through fluorescence; [& this IR is what increases the mating rate]	a+		9	9	95	/t\p149-162 (e.g.)

The Same Table
Sorted according to first-mentioned Author-or-Source (in Last column)

#	ty	mn	Description	sub	ext	nr	far	#2	References and sources
8	H	ky1	Some insect "knobs" are lock&key contact-detectors for scent-molecules			9=		8	
9	H	ky0	(Almost) no insect "knobs" are lock&key contact-detectors for scent-molecules			9=		9	
11	H	sAx	Any contact(A)-discrimination* between scents depends on molecule geometry (*xyz*) *See #2 and its nearness-categories A,B,C			9		11	
12	H	sBx	Some dipole-near(B)-discrimination* between scents depends on molecule geometry (*xyz*) *See #2 and its nearness-categories A,B,C			9		12	
13	H	sBt	Some dipole-near(B)-discriminatn between scents depends on electromagnetic *time-patterns* from the scent molecules (*t*)			9		13	
14	H	sCt	Any dipole-far(C)-discrimination between scents depends on electromagnetic *time-patterns* from the scent molecules (*t*)			9		14	
61	A	flc	"radiation-pumping" of molecules can mislead closeup (especially near Humans), so alternatives could help			9		61	
66	A	cg2	Insect's sensing of concentration-gradient is by d/dt: remembering + retesting — like chemotaxis in Escherichia coli bacteria			9		66	Alberts *et al* (1983), pp575-579
23	E	ecg	*E.coli* uses a *d/dt* gradient to find a **near** target			9		23	Alberts *et al*,(1983), p758
84	E A	odm	Evidence (incl elimination) favouring contact-mechanisms for odour detection in *mammals*, eg template "lock-&-key" fit for specific molecules			9		84	Altner&Prillinger (1980), Davies (1971), Beets(1971)
35	A	d<x	Diesendorf /D4\125.2 "then...molecular structure"[xyz]; anyhow "sensilla shapes become irrelevant to...olfaction" cf.array		F		?	35	Amoore (1971), etc.	NEW: see
80	E	leg	RatMites detect IR (incl. specif. freqs) via setae spines on front leg-tarsals			9		80	Bruce (1971 jul)
3	H	ae2	All (or nearly all) insect innervated "knobs" & pits are electromagnetic aerials (capable of *time-pattern* discrimination, like TV)	b+		5=	9=	3	**Callahan**
4	H	ae1	Some insect innervated "knobs" & pits are electromagnetic aerials (capable of *time-pattern* discrimination, like TV)	b+		5=	9=	4	Callahan
72	A	irS	Ambient (incoherent?) **short**-wave-IR offers source of pumping-energy	a		9	9	72	Callahan
88	E	res	IR → measurable response (whatever the route)	di		5	9	88	Callahan
16	H	bwi	Any "bod"(#15) IR signal is modulated (made discriminable) by *time*-code of wing-flaps etc; [*t*-code]	a.		5	5	16	Callahan (1965a, ...)
81	F	las	VisibleLight: Laser efficiency in producing action-potential "spikes" in nerves >> mere mixed-phase monochrome efficiency (by 42×),	a^		5	5	81	Callahan (1968)[ApplOpt7:1425-30] Bruce(1971)[AnESAm64:925-31]

#		cod	Description	e			#	Reference
91	F	cld	Female moths & food crops → pheromones or other chem "odours" — but which may also have significant IR-optical properties	a+		5	9	91	Callahan etc
40	E	sp#	Seems: No reported direct evidence that *IR*→action potential spikes —— [yet Callahan did find such spikes for *visible* light ("gating": see "spL" (#94)).]	b^	5	5	40	Callahan(1968)p1425-; Hsiao('72), Diesendorf
94	F	spL	Callahan did find action-potl. spikes for *visible* light ("gating" the IR reception throughout the antenna). — [but apparently no spikes from IR itself]	b	5	5	94	Callahan(1968)p1425-; Hsiao('72), Diesendorf
43	E	ge2	tapering & other geometry of (micro) dielectric insect spines ↔ macro dielectric ≈42	b.	9	9	43	/*\ [**Callahan**: *continued ↓*]
26	A	pi=	Grant's pits seen as aerial types	b+	9	9	26	/*\p138, Grant (1949)
69	F	c~3	The concentration of a scent affects the frequency of its stimulated emission;	a	9	9	69	/*\p175-7, 187, **211**
20	H	el:	Insect cuticle is capable of forming electrets			5	20	/*\p319
42	E	ge1	tapering & other geometry of macro dielectric aerial → match impedance free space [engineering] ≈43	b.	9	9	42	/*\p323c2
44	E	dir	Wolf Spider points spines toward target		9		44	/*\p325, fig.14
52	E	dk~	Wolf Spider finds prey or mate in total darkness (with respect to visible light), & without any antennae		9		52	/*\p326, /t\p133
46	E	irr	Moths have irridescence etc for IR frequencies		9		46	/*\p330
47	E	amp	"Maser-like" Stimulated-emission can → amplification	a^	9	9	47	/*\p331
48	E	tow	Maser-like Stimulated-emission is very common in IR → amplification	a^	9	9	48	/*\p333c1; Townes(1965)^{Sci149}p837
49	E	qm0	Some scent-atom/molec will start with excitation energy when they leave target [but ephemeral]		9		49	/*\p333c2.9
50	F	co/	optical "coherence" can be partial	a`	9	9	50	/*\p334c2.9
51	F	co^	partial "coherence" can, in principle, suffice to override random background noise	a`	9	9	51	/*\p334c2.9
53	A	drx	Molecules do act as dipole aerials — (Townes, 1965; Drexhage, 1970)	d:	9	9	53	/*\p335c1.7; Drexhage (1970)
55	E	wHi	High relative.humidity blocks IR Duplicates irH (74) qv	X			55	/*\p336
74	E	irH	Rising Relative-Humidity increasingly kills off IR signals	d/	9	9	74	/*\p336
45	E	win	Atmos windows for IR match corneal lens transmission windows	d/		9	45	/*\p338-9
56	E	eyI	Corneal lens is an "eye" for incoherent IR — & better than the bee-eye (for visible & UV)	di	9	5	56	/*\p338c2
75	E	ir#	At High Relative-Humidity, insect mating etc fails to occur	d/	9	9	75	/*\p339c2.4
76	E	ir/	At High Relative-Humidity, arthropods spend much time wiping antennae etc (even to exhaustion)	d/	9	9	76	/*\p339c2.8
57	A	#mm	Irrelevant here: how *mammalian* olfaction operates			5	57	/*\p341c2.3
58	A	#zz	Irrelevant here: What happens when directly-destructive intensities are used?	X	5	5	58	/*\p341c2.4
21	H	elt	Electrets might serve as memory elements (& collectively: like a Lamarckian tape-recorder)	L	-	-	21	/*\p341c2.6
70	A	t&e	Spines can have dual roles: tactile AND electromagnetic	b	9	8	70	/*\p342c2.8
41	F	key	Consistent phase-control could serve as callsign ID, different from noise & other signals	a`	9	9	41	/*\p343c1.2 (implied)
59	E	fla	Moths follow pheromone long-range, but then candle-flame at short-range		9		59	/*\p343c1.4, (Fabre,1913; Shorey&Gaston, 1965)
79	E	mir	Mirror-walls→ increased mating-rate;		9		79	/*\p343c2, /t\p152
60	H	flb	IR attraction operates via "radiation-pumped molecules" — (method "1": $_{RRT}$) ≈31	a:	9	9	60	/*\p343c2.2
71	F	ir^	Ambient IR remains abundant at night	a	9	9	71	/*\p344 (eg)
37	E	vib	Oft-seen "vibrations" of antennae [These "must have some meaning"]	c	9	8	37	/C3\112.2 — + (C/*\321c1> 1965b$^{AnESAm58:159-69}$)
33	A	d>>	For "far" dipole-range (d>λ), phase patterns are const <u>with respect to *time*</u>, so *d* "makes no difference"		9		33	**/C3**115.1
36	E	rub	Insect is "constantly rubbing" especially in humid conditions [This "must have some meaning"]	c	9	8	36	/C3\p112.2
38	A	oft	Oft-seen behaviour or bio-structures must have significance (else eliminated by evolution)	c	9	8	38	/C3\p112.2
30	A	+ru	Some Energy for pheremone IR signals from rubbing;	c	5	5	30	/C3\p113.38: Q: /D2?\107.1
31	F	+fl	Some Energy for pheremone IR signals via fluorescence ex blue/UV/...; ≈60	a:	9	9	31	/C3\p113.38: Q: /D2?\107.1
78	E	u&s	Strong interaction effects increase the mating-rate, [eg. UV *PLUS* pheromone-scent — see "u:=" (95)];	a+	9	9	78	/t\p149-162 (e.g.)
95	H	u:=	UV *PLUS* pheromone-scent → IR through fluorescence; [& this IR is what increases the mating rate]	a+	9	9	95	/t\p149-162 (e.g.)
64	H	fl3	Use of close-up homing-method 3: traditional <u>olfaction via concentration-gradient</u> (perhaps via some roundabout effect)		9		64	/t\p187
67	A	cg3	Insect's sensing of concentration is by the frequency of its nearby stimulated emission;		9		67	/t\p187,fig.20
68	H	cg#	Frequency of the target-female's pheromone IR emission indicates its concentration, hence how near it is. Could aid targeting.	a	5	5	68	/t\p189 [**Callahan**: *Last Ref*]
63	H	fl2	Use of close-up homing-method 2: "normal" incoherent-light-or-IR <u>vision</u> —		9		63	common assumption
65	A	cg1	Insect's sensing of concentration-gradient is by d/dx: comparing 2+ sensors simultaneously;		9		65	common assumption

#		code	Statement	g				#	Reference
73	H	irL	Ambient (incoherent) **longer**-wave-IR constitutes **noise** which will kill the needed signals. [NEG]	a`		9	9	73	**Diesendorf**
27	H	phm	Some (discriminable) IR signals come from pheremone molecules;	a+		9	9	27	Diesendorf:/D0\34.7
32	A	peg	Grant's "peg" = pit-sensilla, well-placed to "fire" dendrite; → action-potential spike (or TEM mode fibre-optic signal! — NEW)	b		9	9	32	Diesendorf:/D0\36.8, Grant, NEW
28	A	+sp	Energy for pheremone IR signals can come from mere black-body spontaneous emissn; [*denied by Diesendorf*]	a!		9	9	28	/D0\42-3
29	A	+bo	Energy-supply for any pheremone IR signals must be adequate & sustainable (≈15)	a.		9	9	29	/D0\44+
85	A	emp	Proof of C's ae(1 or 2 — idea of A→IR→Z) requires positively demonstrating IR→Z in absence of A. [Empirical insistence]		M	-	-	85	/D2\p106.6, 106.7
62	E	fld	Despite the case for closeup homing via "2 & 3", insects *are* still misled — as if using "1" alone			9		62	**Fabre**
22	E	fab	**far** detection is possible (when no scent molecules could be reaching the receptor)	a			9	22	Fabre, Laithwaite
2	H	<ch	We should distinguish 3 range-zones for any possible chemical olfaction: (A) **Contact** mol/ receptor; (B) "**Dipole-near**" (<50nm?); (C) "**Dipole-far**" (>50nm)			9		2	from standard Dipole Theory
24	E	pit	Grant's pits have geometry compatible with their being electromagnetic aerials;	b+		9	9	24	**Grant** (1949)
25	E	pir	Grant's pits: size is such that, if aerials, they are appropriate for IR reception	b+		9	9	25	Grant (1949)
82	E	mol	Enantiomeric (opt.isomer) forms of scent molecs → different responses after conditioning to one of them — in locust & bee — *cit./D2\p108.4 (#logic!)*			9		82	Kafka+3(1973)[JCompPhio87,277;+(1971?)]
83	E A	odi	Circumstantial evidence favouring contact-mechanisms for odour detection in insects, eg template "lock-&-key" fit for specific molecules			9		83	Kaissling (1971)
7	H	ky2	(Almost) all insect "knobs" are lock&key contact-detectors for scent-molecules			9=		7	Kettlewell; /*\326c2"fit"
1	H	<yd	We should distinguish Laithwaite's 2 target-range-zones: near (<100yds), far (>=100yds)		M	*	*	1	**Laithwaite** (1960)
17	H	ant	Whole antenna could theoretically act as an aerial for FIR (20-200μm);	b		9	9	17	Laithwaite (1960 Jul)
18	F	+++	Whole antenna is like a military "fishbone" aerial array for radar;	b		5	9	18	Laithwaite (1960 Jul)
19	E	off	Signal "switched off" soon after mating;	a			9	19	Laithwaite (1960 Jul)
15	A	bod	Some (discriminable) IR signals come from the target's body heat; (≈29)	a.		5	5	15	Laithwaite (1960 Jul); critic/0\34.7
54	A	dco	Human retinal cones may well serve as dipole aerials — [eye oscillation — NB]	d:		9	9	54	Myers (1965) /*\p342c2.4
34	A	d<t	For "near" dipole-range (d<<λ), phase patterns are **different**, *NOT absent* as Diesendorf, /D2\109.3 implies			9		34	NEW
77	H	coh	For Callahan (/*\p316+) (& perhaps Groner, his source?), "coherence" actually means *"consistent phase-control"*		D			77	NEW
87	E	lip	IR signals (as such) may travel along dendrites, thus obviating any need for Action potential spikes (& explaining why C didn't find them); Dupl 86		X			87	NEW
90	A	dst	Geometry, frequency, & phase distributions (or cloud emission) — "bullseye" model	a+			9	90	NEW
89	E	nat	Natural coherence (phase correlation), eg for expts in Fresnel's day	a`		9	9	89	NEW (in this context)
39	H	spi	Assume any IR reception → response via action-potential "spike" **"[A]"**	b^		9	9	39	physiologists' standard assumption
86	H	sp~	IR reception can be conveyed direct to the dendrite **as** natural IR, (without needing any "spike"); — then conducted on dendrite surface [RRT] **"[R]"**	b^		9	9	86	Schriever(1920) | NEW;
93	F	mye	Time-pattern information capture from myelin segment → molecular demodulation?	b			9	93	Traill (2005b)
6	F	ae=	TV, radio, radar, etc have "knobs" which serve as electromagnetic aerials capable of *time-pattern* discrimination	b		5	9	6	well known
10	E	ky=	The immune system uses molecular lock&key contact-detectors for identification; (xyz)			9		10	well known
92	F	wvg	Time-pattern information capture from macro-waveguide → TV demodulation etc	b			9	92	well known