containers covered with a black cloth. Cotton wadding soaked in 10% sucrose solution served as the food source. In another experiment, 20 males were similarly exposed to varying quantities of the oil and crossed with untreated females. Eggs laid and hatched were recorded daily. In both experiments the females were dissected after death to ascertain mating by scoring the presence of spermatophores in the bursa.

Results and discussion. 75% of the control females mated and laid, on the average, 238 eggs/female 2-7 days after pairing. Only 40% of the treated females mated and they laid, on the average, 142 eggs/female after 7.5 days. On the other hand, only 1 (5%) of the treated males mated and the female laid 81 eggs after 13.9 days. Similar results were obtained when the experiment was repeated with a larger number of insects. In the 2nd experiment, matings between treated males and untreated females increased as the amount of the oil was successively reduced (table). In all the experiments the preoviposition period increased with the increase in the quantity of oil, but average egg laying per female under control and under treated conditions did not differ significantly.

Effect of *Blumea eriantha* oil on reproduction in *Earias vittella* F. males

	Amount of oil (µl)			
	0	5	10	15
Matings (%)	90.0	70.0	15.0	10.0
Preoviposition period (days)	3.3	5.1	5.3	7.0
Eggs per mated female	314	249	217	299
Egg hatch (%)	93.9	92.9	95.3	81.2

Extension of the preoviposition period in the case of treated moths resulted not from the repellent action of the oil but was due probably to the delay in mating. This became evident when mated females were provided with treated oviposition sites; they laid the same number of eggs at the same time as those in the control situation. It therefore appears that Blumea oil through vapor action interferes predominantly with some component of the mating behavior of males. High concentration of vapors of an essential oil from *Acorus calamus* have been shown to impede copulation in *Dysdercus koenigii*[3].

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An attractant pheromone with common properties in three reptile ticks

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Summary. Female reptile ticks produce a pheromone which attracts conspecific, and less strongly, non-conspecific males over short distances.

Animal mating behaviour involves a series of signals and responses between males and females[1], which have the function of ensuring efficient fertilization[2]. In ticks pheromone signals have been widely reported[3-9]. In the reptile tick, *Aponomma hydrosauri,* male searching starts in response to a signal from females which have fed on a host for over 5 days[10,11]. Searching is not directed specifically towards the female[10]. This paper discusses how a searching male locates and recognizes a receptive female. 3 reptile tick species were used to compare responses between conspecifics and non-conspecifics.

Materials and methods. Laboratory stocks of *A. hydrosauri* originated from Tickera, *Amblyomma limbatum* from Mt. Mary, and *Amblyomma albolimbatum* from Arno Bay, all in South Australia. Newly moulted adults were kept in separate vials for 1-8 months. Males and females were attached to separate, individually isolated lizards, *Trachydosaurus rugosus,* for 14 days, and then detached to separate vials (23 °C; 80% relative humidity). Experiments were conducted in the next 36 h under dim red light in the first half of the dark phase of a 12:12 h photoperiod, when tick reproductive activity is highest[3].

The experimental technique was derived from that of Leahy et al.[12]. Plastic petri dishes (8 cm diameter) were divided into 8 equal sectors. A female, enclosed in a 1.0 cm^2 gauze bag to prevent male contact, was placed in 1 sector, and empty gauze bags in the other 7. The sector a male occupied at 30-sec intervals, the number of contacts, and the time it spent in contact with each bag, were recorded for 30 min following addition of a male to the dish. A new dish with a new orientation was used for each trial. Previous observations[13] had showed that males move randomly in an empty dish.

Males of each species were tested with females from 4 groups, unfed and fed conspecific females and fed females of each of the other 2 species, using a modified latin square sequence. A male was tested only once with females from each group. Each female was only used in 3 trials. In experiment 2, males were tested with conspecific and non-conspecific females in bags in opposite sectors of the dish.

Results. In experiment 1 (table 1), when bags held unfed females, males had random distributions in the dishes and the mean time in contact, and the number of contacts did not differ significantly from empty bags. With fed conspecific females males were significantly more often in the sector with the female bag. They made significantly more contacts, and spent significantly more time in contact with female bags than with empty bags. By the same criteria non-conspecific females also attracted males (table 1), although the attraction was not as strong as to conspecific females. Differential attraction was tested further in experiment 2. The results (table 2) compare male response to the 2 bags containing females. *Ap. hydrosauri* were more attracted to conspecific than non-conspecific females. *Amb. albolimbatum* preferred conspecifics to *Amb. limbatum,* but were significantly less in conspecific sectors than those containing *Ap. hydrosauri* females. *Amb. limbatum* males showed no significant discrimination.

Discussion. 2 different female signals have been described in *Ap. hydrosauri* mating behaviour[10,11]. The 1st, an exci-

Table 1. Attraction of males to females in gauze bags during 30-min trials; p is result of statistical comparison of male response to female containing bags (in sector 1) and empty bags (in sectors 2–8) using chi-squared tests for number of times in each sector and Wilcoxon matched pairs signed rank tests (or Mann-Whitney U tests where the number of pairs is < 6) for mean number of contacts and mean time in contact. Comparing the response of males to conspecific and non-conspecific females, * not significantly different, ** $p < 0.05$

Males (n)	Females (n)	% of times ♂♂ in sector 1 at 30 sec intervals		Mean No. of contacts (s.e.) per sector			Mean time (s.e.) in contact per sector (secs)		
		%	p	SECT 1	SECT 2–8	p	SECT 1	SECT 2–8	p
hyd (12)	Unfed *hyd* (12)	10.8	n.s.	0.6(0.2)	0.1(0.1)	n.s.	4.7(0.8)	0.5(0.1)	n.s.
albo (12)	Unfed *albo* (12)	11.3	n.s.	0.5(0.2)	0.2(0.1)	n.s.	4.1(0.8)	0.9(0.2)	n.s.
limb (12)	Unfed *limb* (12)	11.5	n.s.	0.2(0.2)	0.2(0.1)	n.s.	0.6(0.4)	0.6(0.4)	n.s.
hyd (21)	Fed *hyd* (7)	39.2	< 0.001	2.9(0.3)	0.2(0.1)	< 0.01	566.7(4.7)	0.5(0.1)	< 0.01
hyd (6)	Fed *albo* (3)	20.3	< 0.001**	1.5(0.5)	0.0(0.0)	< 0.05*	158.3(7.0)	0.0(0.0)	< 0.05**
hyd (5)	Fed *limb* (3)	28.7	< 0.001**	2.6(0.6)	0.1(0.1)	< 0.01*	60.0(3.3)	0.8(0.3)	< 0.01**
albo (21)	Fed *albo* (7)	17.9	< 0.001	1.8(0.3)	0.5(0.1)	< 0.01	121.3(0.9)	4.1(3.6)	< 0.01
albo (8)	Fed *hyd* (3)	22.9	< 0.001**	1.8(0.4)	0.2(0.1)	< 0.05*	123.6(5.1)	0.4(0.1)	< 0.05*
albo (9)	Fed *limb* (3)	14.4	n.s.*	2.0(0.4)	0.1(0.1)	< 0.01*	46.6(2.0)	0.4(0.1)	< 0.01*
limb (15)	Fed *limb* (5)	19.1	< 0.001	0.7(0.3)	0.04(0.0)	< 0.05	67.7(3.4)	0.1(0.7)	< 0.01
limb (9)	Fed *hyd* (3)	17.4	< 0.001*	1.2(0.4)	0.03(0.1)	n.s.*	16.1(1.5)	0.1(0.6)	< 0.05**
limb (8)	Fed *albo* (3)	20.4	< 0.001*	1.5(0.4)	0.1(0.1)	< 0.05*	27.0(1.8)	0.3(0.1)	< 0.05**

Table 2. Choice by males of 2 females in gauze bags during 30-min trials; p is result of statistical comparisons of male response to conspecific females (in sector 1) and non-conspecific females (in sector 5) using tests as in table 1

Male (n)	Females	No. of times ♂♂ in secor at 30-sec intervals			Mean No. of contacts (SE) per sector			Mean time (SE) in contact per sector (sec)		
		Section 1	Section 5	p	Section 1	Section 5	p	Section 1	Section 5	p
hyd (6)	*hyd* *albo*	125	33	< 0.001	2.3 (0.4)	1.0 (0.2)	< 0.01	406.3 (4.9)	21.8 (1.4)	< 0.01
hyd (6)	*hyd* *limb*	104	46	< 0.001	2.5 (0.7)	1.8 (0.5)	n.s.	308.2 (8.1)	62.7 (3.5)	n.s.
albo (12)	*albo* *hyd*	109	142	< 0.05	1.5 (0.4)	1.1 (0.4)	n.s.	51.8 (2.4)	32.4 (2.3)	n.s.
albo (9)	*albo* *limb*	152	95	< 0.001	0.6 (0.3)	0.4 (0.2)	n.s.	7.7 (1.1)	8.3 (1.2)	n.s.
limb (12)	*limb* *hyd*	158	189	n.s.	1.1 (0.3)	1.17 (0.4)	n.s.	160.4 (5.1)	125.4 (4.6)	n.s.
limb (9)	*limb* *albo*	126	129	n.s.	0.8 (0.3)	1.2 (0.3)	n.s.	178.7 (5.3)	173.4 (4.7)	n.s.

tant, stimulates male detachment and non-directed searching. The 2nd, a courtship signal, initiates courtship activity after contact. This paper shows another signal from fed females, a short distance male attractant, effective without contact and not transmitted via a host. The attractant is probably a pheromone. It is a component of the mating behaviour of all 3 species. It may be the excitant, which becomes a directional signal at close range, or another function of the courtship signal. Unfed females, which produce neither excitant nor courtship signals[10,11], did not produce the attracant. It attracts both conspecific and non-conspecific males, although males are less attracted to non-conspecific females. This suggests that each species has a pheromonal attractant differing slightly in structure from, but still recognizable by, the other species. If the attractant is a multi-component pheromone[9], each species may have some, but not all components in common.

Modifications of the attractant during the evolutionary divergence of these species have not been sufficient to make the signal unrecognizable to the other species. Non-specificity of pheromones has been reported for other ticks[6,8,9]. Since male attraction is only one of a sequence of signals and responses in the mating behaviour, this need not lead to free interbreeding in sympatry. However it could result in males directing courtship behaviour to non-conspecific females in some circumstances. A subsequent reduction in reproductive success might be one of the factors preventing range overlap at the common boundaries of these ticks[14,15].

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