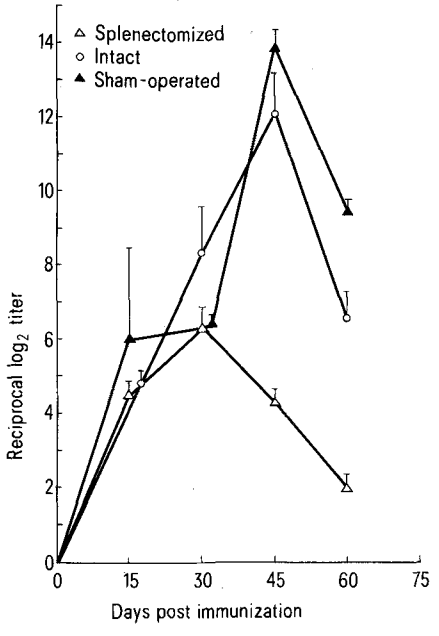
bodies[2-12]. Our findings are, however, contradictory with those obtained in the lizard, *C. versicolor*, where adult splenectomy entirely abolishes humoral response to sheep erythrocytes[13,15]; a thorough evaluation of results therefore appears warranted.

It is well-known that effect of splenectomy varies, depending on antigen type, dose and route of administration, experimental animal and on presence or absence of a number of peripheral lymphoid centers other than spleen[2,3,9,12,15]. In our study, ambient temperature, antigen type, dose as well as route of injection were not unlike corresponding experimental conditions in earlier investigations on lizards[13,15,18], but a different species of lizard was examined. *C. versicolor* is a species characterized by the fact that a large proportion of intact and sham-operated animals produce no circulating antibodies to i.p. injected sheep erythrocytes, and in responding lizards, titer is rather low[13,15,18]. Moreover, *Calotes* entirely lacks gut-associated lymphoid tissue except for a cloacal aggregate[15,18]. Splenectomy removes the major source of antibody-producing cells, thus leading to complete abolition of humoral response.

We have shown that splenectomy has rather marginal effects on reptilian humoral response by using the lizard, *S. scincus*, which displays consistent and powerful response to heterologous erythrocytes (figure). Besides, *S. scincus* is endowed with an extensively developed array of gut-associated lymphoid aggregates. Removal of spleen leaves alternative sites of organized lymphoid tissue, and thus would not drastically impair immunological ability. Nonetheless, splenectomy in *Scincus*, severely depressed titer of circulating antibodies; this finding suggests that spleen has a crucial role in immune defense in lizards as in higher vertebrates[19].



Humoral response in *Scincus scincus*. Vertical bars represent SE.

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Chemical crypsis in predatory ants

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Summary. The repellent responses of worker termites to ants are determined by the exocrine gland secretions of the latter. Specialized termite predators produce non-repellent aliphatic alcohols as the major components of their mandibular glands, whereas unspecialized con-generics usually produce repellent ketones and aldehydes.

Our researches on ant predators of termites in West Africa have shown that chemical stimuli play an important role at several stages of the predator-prey interaction[2,3]. A successful predator must avoid early detection by its prey. Some ants have pheromones used in alarm and recruitment of nest-mates to which the termites themselves are insensitive. We believe this to be analogous to crypsis dependent upon visual concealment.

Decamorium uelense, a myrmicine ant, which was studied in the Southern Guinea savanna at Mokwa, Nigeria, is a specialized predator of small termites which forage within their food of roots, grass stems and wood[2,4]. Single workers (scouts) search for foraging termites. A successful scout returns to the colony and recruits a group of 10–30 workers who proceed to the termite foraging area. They then dig into the foraging galleries of the termites and immobilize

Table 1. Repellency[a] of whole anaesthetized myrmicine ants to termite workers (Macrotermitinae)

	Macrotermes bellicosus	*Ancistrotermes cavithorax*	*Microtermes* sp.	Major mandibular gland component (%)
Carebara sp.	○	○	○	
Crematogaster sp.A	+	+ +	+ +	3-Octanone (85)
Crematogaster sp.B	+	+	○	3-Octanol (65)
Crematogaster sp.C	○	○	○	6-Methyl-3-octanol (97)
Crematogaster sp.D	+	+ +		3-Octanone (82)
Crematogaster sp.E	+ +	+ +	+ +	3-Octanone (91)
Crematogaster sp.F	+ + +	+ +	+ +	Hex-2-enal (85)
Pheidole sp.A	+ +	+ +	+ +	3-Octanone (81)
Pheidole sp.B	+		+	
Pheidole sp.C	+	+	+	
Messor regina	○	○	○	
Messor sp.B	○	○	○	
Decamorium uelense	○	○	○	3-Octanol (99)
Tetramorium sericeiventre	+	+	+ +	3-Octanone (96)
Tetramorium guineense	+	+	+	3-Octanone (99)
Tetramorium termitobium	○	○	○	2-Undecanol (99)
Tetramorium angulinode	+ +		+ + +	Perillen (95)
Tetramorium sp.D	+ +	+ +		Perillen (99)

[a] The scoring systems used for the termites was as follows: No response to stimulus (score 0); pause < 1 sec, resume forward (1); pause > 1 sec, resume forward (2); pause > 1 sec, retreat (3); pause < 1 sec, retreat (4); immediate retreat with alarm behaviour[5], or alarm behaviour at or near the stimulus (5). The scores were analysed to give a 'degree of repellency' (DR) from DR = total behavioural score achieved/total behavioural score possible. The DRs were grouped for presentation as follows: 0.00–0.39 (○); 0.40–0.59 (+); 0.60–0.79 (+ +); 0.80–1.00 (+ + +).

Table 2. Responsiveness (DR[a]) of termite major workers (Macrotermitinae) to pure compounds[b]

	Macrotermes bellicosus	*Ancistrotermes cavithorax*	*Microtermes* sp.
2-Hexanone	+ + +	+ +	+ +
2-Octanone	+ +	+ +	+ +
2-Nonanone	+ +	+ +	+
2-Decanone		+ +	+
2-Undecanone	+	+ +	+
2-Dodecanone	+	+	+
3-Octanone	+ +	+ +	+ +
3-Decanone	+ +	+ +	+ +
4-Heptanone	+ +	+	+
Octanal	+ +	+ +	+ +
Pentanal	+ +	+ +	
1-Heptanol		○	○
1-Octanol	○	○	○
1-Pentanol		○	
1-Nonanol	○	○	
2-Undecanol	○	○	○
2-Dodecanol	○	○	○
3-Heptanol	○	○	○
3-Octanol	○	○	
4-Methyl-3-heptanol	○	○	○
6-Methyl-3-octanol[c]	○	○	○
Perillen[d]	+	+ +	+ +

[a] Footnote Table 1. [b] Presented as 1 µl of a 0.01% (weight) dichloromethane solution; solvent allowed to evaporate before presentation. [c] Fraction from *Crematogaster* sp.C. [d] As excised mandibular gland from *Tetramorium angulinode* (95% of secretion).

them by stinging. Observations of groups of 25 termites (*Microtermes* sp. or *Ancistrotermes cavithorax* major workers), revealed that the ants did not disturb the termites and could move freely among them before they attacked and immobilized them. In contrast, when workers of some *Pheidole* or *Crematogaster* species were introduced, the termites retreated from the ants and gave oscillatory alarm displays[5].

Within the genus *Crematogaster,* it was found that 2 species (B and C), which were semi-specialized termite predators[2], did not antagonise *Microtermes* sp. in the perspex assay chambers; neither did *Carebara* sp. or *Tetramorium termitobium* which habitually live in termite nests. A series of experiments was carried out to determine the possible chemical reasons for the lack of antagonism between these ants and their termite prey.

Foraging termites were collected from wooden bait blocks[2] and 25 major workers were placed in a perspex bioassay chamber, consisting of 2 45-mm diameter roofed chambers (4 mm deep) connected by a roofed passage (60 mm × 5 mm). Access to the passage was controlled by sliding gates. The termites were induced to move from one of the chambers by exposure to light and their behaviour noted and scored as they approached the material for bioassay which was placed in the centre of the passage (table 1, footnote).

The first series of assays was carried out with live anaesthetized myrmicine ants. The results (table 1) indicated that ants of many genera were repellent to termites. Exceptions were *Crematogaster* sp.C and sp.B (to *Microtermes*), *D. uelense*, *T. termitobium* and 2 seed harvesting *Messor* species.

Further bioassays were carried out with extracts of whole ants, sections of ants and excised mandibular glands and sting apparatus. The heads and gasters of all the repellent myrmicines released withdrawal in the 1–5 mm range, the heads being the most effective[2]. Tests on excised glands showed that the mandibular glands were the most active, and that mandibular glands of non-repellent ants (*Crematogaster* sp.C, *D. uelense*) did not repel the termites.

The mandibular gland components of myrmicines in the tribes Tetramoriini and Crematogasterini were analyzed. Determination was by solid-sample gas chromatography[6] on excised glands and heads, gas chromatography on dichloromethane extracts, linked GC-mass spectroscopy and co-elution studies with authentic and synthetic samples.

The glandular components of the *Crematogaster* species follow the pattern found by Crewe et al.[7] with 3-octanone being dominant in most subgenera, except *Atopogyne* (sp.F), where hex-2-enal predominated. 2 exceptions from

Mokwa are the non-repellent *Crematogaster* sp.C (6-methyl-3-octanol dominant) and sp.B (3-octanol dominant).

In the tribe Tetramoriini, most *Tetramorium* species have a mandibular gland secretion akin to *Crematogaster* with 3-octanone dominant. An exception is the lestobiotic *T. termitobium* in which 2-undecanol predominates. Repellent *Tetramorium* species contain large quantities of perillen, a compound previously found in the formicine *Lasius fuliginosus*[8]. *D. uelense* has 3-octanol as the major component.

A series of bioassays was carried out on synthetic samples and natural fractions of ant mandibular gland components and related compounds. Aliphatic alcohols were not repellent to the termites, but repellency was observed with aliphatic ketones and aldehydes (table 2).

It appears that those myrmicines which are specialized or semi-specialized termite predators have aliphatic alcohols in the mandibular glands (possibly for the communication of alarm or other behaviour) instead of the more repellent carbonyl and other compounds which are usually present in other members of the same genera[7,9]. This enables the ants to move among the termites without being detected.

Bioassays performed on extracts of ants indicated that all parts were repellent, but that this repellency originated from exocrine glands in the head. In *Apis mellifera*, it was found that trans-9-keto-decenoic acid, part of the 'queen substance' from the mandibular glands could be found all over the cuticle[10]. A similar spreading of the compounds from the mandibular glands may also explain the repellency of some ants to termites.

We conclude that small quantities of glandular compounds, released on to the cuticles of ants, may form cues by which termites recognise their predators. Those ants which have been able to emphasise components of their secretions which termites cannot detect are able to become successful termite predators by virtue of this 'chemical crypsis'. These findings may help to explain the great diversity of exocrine secretions found in the Formicidae[9].

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Cerebral ammonia production during hypoglycaemia in the newborn calf[1]

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Summary. The effect of insulin hypoglycaemia on cerebral blood flow, and cerebral metabolic rates of glucose, oxygen and ammonia was investigated in the unanaesthetized newborn calf. A net loss of ammonia from the brain occurred during hypoglycaemia, and was greater in convulsing than in comatose animals.

Ammonia accumulates in brain tissue deprived of an adequate supply of glucose. This has been demonstrated both in vitro[3,4] and in vivo[5,6] by the measurement of brain tissue ammonia concentrations. In addition, a net loss of ammonia by the brain to the circulation has been observed during insulin hypoglycaemia in the anaesthetized dog[5], but could not be quantified as cerebral blood flow was not measured. These experiments were undertaken to quantify cerebral ammonia production during insulin-induced hypoglycaemia in the unanaesthetized newborn calf.

Cerebral metabolism was determined by the simultaneous measurement of cerebral blood flow and arterio-cerebral venous concentration differences of oxygen, glucose and ammonia. Cerebral blood flow was measured by an inert-gas technique[7] using molecular hydrogen gas and intravascular catheter mounted platinum electrodes[8,9]. Metabolite estimations were performed in duplicate on paired samples withdrawn simultaneously from the aorta and sagittal dural sinus at the beginning and end of each flow determination. Sampling catheters and electrodes were inserted under general anaesthesia (halothane) on the day prior to the experiment. Ammonia was estimated within 2 h of collection using a specific enzymatic technique[10]. Glucose was measured with a Beckman Glucose Analyser (Mark 2) and whole blood oxygen content by a polarographic technique[11]. Arterial blood gas tensions, pH and blood pressure were also monitored. The values for flow and metabolism refer to tissue drained by the sagittal dural sinus, which is predominantly cerebral cortex.

The experiments were carried out on 15 pedigree Jersey calves aged between 1 and 22 days. Measurements were made in unanaesthetized, unrestrained animals during normoglycaemia and following i.v. administration of insulin (Soluble Insulin B.P. Wellcome, 4 IU/kg b.wt).

Observations made during hypoglycaemia are subdivided into 2 groups according to the clinical state of the animal. 18 observations were made in animals showing signs of somnolence and lethargy (comatose), and 7 during generalized seizures. No significant arterio-cerebral venous concentration difference for ammonia was observed during normoglycaemia, but a statistically significant net loss of ammonia from the brain was found during hypoglycaemia. Comparison of measurements made during hypoglycaemic seizures, with those made in comatose hypoglycaemic animals, showed a significantly raised cerebral blood flow and oxygen consumption ($p < 0.001$), a lower molar ratio of glucose uptake to oxygen consumption ($6 \times CMR_{Gl}/CMR_{O_2}$) ($p > 0.1$), and a higher rate of cerebral ammonia production ($p < 0.01$) (table).