intermedia and *P. davidsonii*, higher than those of the alpine plants of *S. hystrix*, probably reflect the fact that these species are largely restricted to alpine habitats.

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Mandibular Gland Pheromone of Worker Honeybees

THE mandibular gland secretion of the worker honeybee, *Apis mellifera* L., contains 10-hydroxy-Δ^2-decenoic acid[1] and, at least in older workers (foragers), 2-heptanone[2]. Maschwitz[3] reported that the secretion of this gland evoked an aggressive reaction from bees at the entrance of their hive, and Shearer and Boch[2] obtained a similar reaction with 2-heptanone. Simpson[4] found that the mandibular gland secretion, which has a strong but fugitive smell, repels foraging honeybees when added to a dish of sucrose syrup. I have shown that 10-hydroxydecenoic acid does not repel foraging honeybees but that 2-heptanone does.

Worker honeybees were trained to collect sucrose syrup from a dish on a glass topped table (60 cm in diameter) which could be rotated. With about a hundred bees visiting the table, the dish was removed and the glass top of the table was replaced with a clean one, and two glass dishes (each 7 cm in diameter and 1 cm deep) were placed opposite each other at about 18 cm from the centre of the table. The repellent nature of the odour of a particular substance was tested by placing a sample in one of the dishes with a sample of a control substance in the other dish. Both dishes were covered with aluminium gauze. During the tests syrup was not given and the table was slowly and continuously rotated so that neither dish was in a constant position relative to the surroundings. A bee alighting on the gauze covering of a dish was immediately driven off and the gauze was replaced by a clean piece. The number of bees which landed on each dish is shown in Table 1. The materials tested were the crushed heads, thoraces and mandibular glands of foragers, 10-hydroxy-Δ^2-decenoic acid and 2-heptanone. The 10-hydroxydecenoic acid was used in solid form, but the others were mixed with medicinal paraffin to retard evaporation of scent. The control substance was paraffin alone. Each test lasted 10–20 min.

Table 1. REPELLENCY OF VARIOUS MATERIALS

Test	Dish *A* Contents	No. of bees landing	Dish *B* Contents	No. of bees landing	Significance of difference
1	Crushed heads of ten foragers in 5 ml. paraffin	9	5 ml. paraffin only	60	$P < 0.001$
2	Crushed thoraces of ten foragers in 5 ml. paraffin	38	5 ml. paraffin only	35	Nil
3	Crushed heads of ten foragers in 5 ml. paraffin	7	Crushed thoraces of ten foragers in 5 ml. paraffin	57	$P < 0.001$
4	Crushed mandibular glands of ten foragers in 5 ml. paraffin	11	5 ml. paraffin only	65	$P < 0.001$
5	80 μg 10-hydroxydecenoic acid*	40	Nil	46	Nil
6	150 μg 2-heptanone† in 5 ml. paraffin	7	5 ml. paraffin only	52	$P < 0.001$
7	Crushed heads of ten foragers in 5 ml. paraffin	22	150 μg 2-heptanone† in 5 ml. paraffin	18	Nil
8	Crushed mandibular glands of ten foragers in 5 ml. paraffin	12	150 μg 2-heptanone† in 5 ml. paraffin	13	Nil

* Arbitrary quantity.
† Minimum amount in heads (ref. 2) of ten bees.

Foragers were strongly repelled by the odours of crushed heads and crushed mandibular glands, which contain both 2-heptanone (15–23 μg in each bee)[2] and 10-hydroxydecenoic acid, but were unaffected by crushed thoraces. The odour of 10-hydroxydecenoic acid neither attracted nor repelled foragers, but 150 μg of 2-heptanone repelled them as strongly as either the crushed heads or the crushed mandibular glands of ten foragers. The ability of the mandibular gland secretion of a forager to repel other foragers probably depends largely, or entirely, on its content of 2-heptanone.

It is unlikely that this pheromone is used by foragers to warn others away from an exhausted food source[4] but if, as has been reported[2], it plays a part in colony defence, perhaps it is released by guard bees to deter potential robbers from the honey stores.

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Onset of Echo-location Clicking in *Collocalia* Swiftlets

As a result of work initiated at the Sarawak Museum, Medway described and analysed the echo-location system of the cave dwelling "edible-nest swiftlet", *Collocalia maxima*, of Borneo[1]. Other work on *C. salangana*, which makes a moss nest (in Borneo), is as yet unpublished[2]; however, the taxonomy and nomenclature of all *Collocalia* are discussed by Medway[3]. The only other bird genus known to make use of echo-location is the central American oil-bird, *Steatornis*[4]. In both genera the basic element is a loud click of short duration, comprising mixed frequencies, all audible to man.

During 1965, while engaged on an extension of some of this Museum's *Collocalia* research at Niah Great Cave[5], I kept numerous young swiftlets which had fallen from nests during the destructive harvesting of nests, mainly October–December[6], in order to test their capacity for survival without food. In nestlings with wing feathers emerging from the sheath, the primaries continued to grow despite steady loss of body weight. For example, *C. maxima*, which fell with a wing span of 114 mm and weight of 20 g, died after 271 h with a wing span of 124 mm and a weight of 9·5 g; and *C. salangana*, which fell with a wing span of 70 mm and a weight of 12 g, died after 295 h, with a wing span of 79 mm and a weight of 7 g. After these had reached the stage where feather sheaths persisted only on the bases of the three outermost primaries, the characteristic echo-location clicks were suddenly heard, in addition to the previous screeching and chirping. These juveniles were isolated from adults and the caves, in cages where echo-location could neither be learned nor be of any use. *C. maxima* made its first clicks when the wing reached 124 mm (outer three primaries still partly sheathed at base) compared with the adult wing of 125–140 mm (measurements taken from the West Borneo race *C.m. lowi* Sharpe, of which adults below 130 mm are