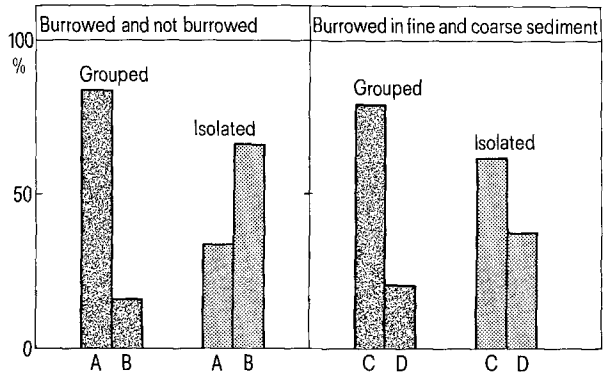
## Gregarious Behaviour in a Benthic Marine Amphipod (*Corophium volutator*)

The gregarious behaviour of invertebrates in the sea has obvious selective advantages. It can aid sexual reproduction, it may protect some individuals from predation, and it often produces aggregations of animals in the more favourable environments that primary colonisers have explored first. The larvae of many sedentary marine invertebrates are now known to be gregarious[1,2], often responding to some specific chemical present in the adult[3,4]. However, it is not known whether gregariousness is as common amongst mobile adult benthic invertebrates[5–7]. In this communication we show that adults of the mobile mud dwelling amphipod, *Corophium volutator*, are gregarious, and that isolated animals behave differently from animals in groups. The latter experiment is described first.

Previous experiments have shown that grouped animals always prefer fine to coarse sediment[8]. A choice of fine and coarse sediment was therefore offered to groups of animals and to isolated animals (Figure). Animals were offered fine and coarse sediments ni quartered choice dishes, diameter 12 cm, height 6 cm. BARNES, BURN, MEADOWS and MCLUSKY[9] give experimental details. The particle size of the fine sediment was $< 250$ μm and of the coarse sediment 250–500 μm. Grouped animals were offered the choice in groups of 30 to 40 animals/dish and isolated animals at 1 animal/dish. 3 group dishes and 99 isolated dishes were set up. The experiment lasted 1 h. The total number of grouped and isolated animals were 114 and 99 respectively. $\chi^2$ tests were applied to the original data. Most of the grouped animals burrowed while few of the isolated ones did so, 84% compared with 34%. The difference is highly significant ($\chi^2 = 53.62$, 1 d.f., $p < 0.001$). More grouped animals than isolated animals burrowed in the fine, compared with the coarse sediment, 79%:21% and 62%:38% respectively. The difference between the 2 ratios is significant ($\chi^2 = 4.077$, 1 d.f., $p < 0.05$). The experiment has been repeated a number of times with similar results. Other experiments have shown that the behaviour of isolated animals is more variable than grouped animals.

In the second experiment, separate sexes were offered a choice of sediment containing no animals and sediment containing previously burrowed animals (Table). A partition, height 1.5 cm, was placed on the bottom of a choice dish, 12 cm diameter and 6 cm deep, which divided the bottom in half. Muddy sediment from the species' natural habitat which had been sieved through a 800 μm sieve was added to the level of the top of the partition. Sea water was run in to 1 cm from the top of the dish. A further partition was placed above the first, completely dividing the dish so that animals could not move from one side to the other. 15 males or females were allowed to burrow on one side of the partition. After 24 h the upper partition was removed and another 15 males or females were introduced. After 48 h the experiment was stopped and the number of introduced animals in the two halves was counted. Each comparison, female with female, female with male, and so on was repeated twice; there was no difference between the 3 dishes by $\chi^2$, so the numbers were summed giving 45 introduced animals per comparison. Mature females were tested against previously burrowed mature females, mature females against mature males, mature males against mature females, and mature males against mature males. Most of the introduced females burrowed while most of the males did not (Table, column 5). The difference is highly significant ($\chi^2 = 68.16$, 1 d.f., $p < 0.001$). Females strongly preferred




Differences in behaviour of isolated and grouped animals. A) % burrowed; B) % not burrowed; C) % burrowed in fine sediment; D) % burrowed in coarse sediment.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Gregarious behaviour in males and females of *Corophium volutator*

| Sex of introduced animals | Sex of animals that had previously burrowed into sediment | Proportion of introduced animals that burrowed into | | Proportion of introduced animals that did not burrow (%) | No. of introduced animals |
|---|---|---|---|---|---|
| | | Occupied half of dish (%) | Unoccupied half of dish (%) | | |
| ♀ | ♀ | 75 | 18 | 7 | 45 |
| ♀ | ♂ | 84 | 4 | 11 | 45 |
| ♂ | ♀ | 44 | 0 | 66 | 45 |
| ♂ | ♂ | 18 | 0 | 78 | 45 |

burrowing into sediments containing other females or males; males showed the same preference but to a lesser degree (Table, column 3). Both sexes are therefore gregarious, but females more so than males. The difference between males and females is highly significant ($\chi^2 = 43.56$, 1 d.f., $p < 0.001$). The experiment has been repeated many times with similar results.

Prompted by the demonstration of female sexual attractants in adult *Portunus* and *Gammarus*[10,11], we tested for a pheromone that would initiate gregarious behaviour using extracts of animals and water in which animals had been immersed; but the results were too variable and often not significant. At present we do not know how *Corophium* detects sediments containing previously burrowed animals. It may sense the physical presence of U tubes or actually recognise burrowed animals. We are investigating these matters further.

In summary, male and female *Corophium volutator* are gregarious, females being more so than males. Isolated animals behave differently to animals in groups. These results add weight to the view[1] that gregarious behaviour may be as common amongst adult mobile invertebrates in the sea as it is amongst the settling larvae of sedentary species.

*Zusammenfassung.* Untersuchungen im Laboratorium zeigen, dass besonders die weiblichen schlammbewohnenden Amphipoden, *Corophium volutator* (Pallas), in Scharen leben. Isolierte Tiere verhalten sich anders als Tiere in Gruppen. Wegen der grossen Streuung ergaben die Untersuchungen über das Vorkommen eines als Scharenreiz wirkenden Pheromons keine eindeutigen Ergebnisse.

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## Cell Migration in the Intestine of Indian Desert Gerbil (*Meriones hurrianae* Jerdon) and its Relationship with the Radiosensitivity of the Animal

A correlation between the transit time of intestinal cells (time taken by the cells to travel from the crypt to the tip of villus) and radioresistance has been established in certain mammals. Considerable work that has been done on the effect of radiation on the Indian desert gerbil, *Meriones hurrianae* Jerdon, in this laboratory, indicates that the animal is comparatively highly radioresistant. The present investigation seeks to study the cell migration time from the crypts to the tips of the villi in the intestine of gerbil and to see if it is correlated to its radioresistance.

*Material and methods.* The animals, weighing 65 ± 5 g, were collected from the vicinity of Jaipur. They were acclimatized to the laboratory conditions for at least 1 week before the experiment. The animals were sacrificed in pairs from 1 to 120 h (12 autopsies in all) after a single i.p. injection of tritiated thymidine ($H^3T$), specific activity 6.0 Ci/m*M*, at a dose level of 25 μCi per animal. Small pieces of jejunum were fixed in Bouin's fluid and paraffin sections were spread on gelatin-coated slides. They were coated with nuclear emulsion (Kodak NTB2), using dipping method, and kept in the securely wrapped box for exposure at 4 °C for 6 weeks. The sections were developed and fixed following the normal autoradiographic procedure. They were stained with haematoxylin and eosin for studying the migration of labelled cells.

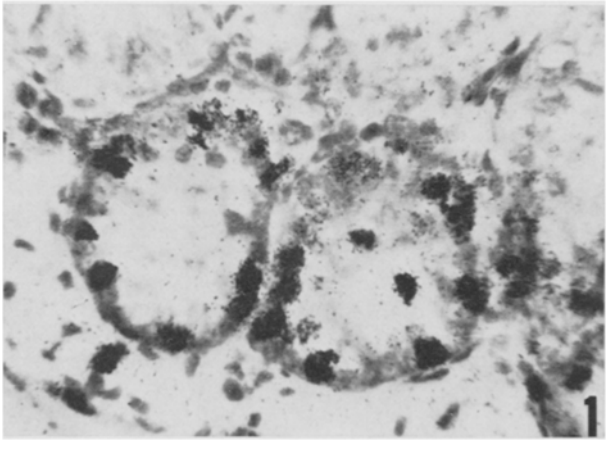

Fig. 1. Intestinal crypts 2 h after administration of tritiated thymidine showing labelled cells. ×400.

*Results and discussion.* At 2 h, many labelled cells are noted within the crypts, most of them confined to the basal region (Figure 1). At 4 h, the labelled cells are seen moving out of the crypts (Figure 2). The migration of cells in subsequent stages becomes slow. At 48 h, most of them are still seen in the lower region of the villi, with only a few of them having ascended about $^1/_3$ of the villous height. Thereafter the movement proceeds at varying rates. The labelled cells take approximately 120 h to reach the tips of the villi (Figure 3). Figure 4 shows the transit time in the small intestine of gerbil as compared to some other rodents.

A correlation between the migration time of the intestinal cells and radioresistance has been established by many workers[1–5]. Figure 5 shows the relationship between the transit time and $LD_{50}$ values. It has been very nearly established that the rodents with slower rate of cell renewal, i.e. longer transit time, have longer survival time or greater radioresistance. The germ-free mouse, pocket mouse and multimammate mouse, which have a transit time of 121 h, 151 h and 134 h respectively, are considered to be radioresistant[6,7]. According to this

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