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Observations and possible function of the striking anterior coloration pattern of *Galathea intermedia* (Crustacea: Decapoda: Anomura)

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Galathea intermedia is common, but cryptic, on Clyde maerl deposits where it lives in small groups of mixed sex and age, sharing shelters (typically dead *Dosinia* shells) to avoid predation. Its appearance is marked by six iridescent blue spots which may play an important role in intra- or interspecific interactions.

Anomuran decapod crustaceans of the genus *Galathea* are widespread in rocky/gravelly subtidal areas around north-western European coasts (Zariquiey Alvarez, 1968). Recent interest in the group has been stimulated by the growing commercial importance of squat lobsters as the target of an expanding European fishery. However, the biology and ecology of these animals remain poorly studied (De Grave & Turner, 1997). Of the six species of *Galathea* known to occur in coastal waters (to 200 m) around the British Isles (Howson & Picton, 1997), five have been recorded in the Clyde Sea area (Allen, 1967). Our attention was drawn to *Galathea intermedia* Liljeborg, the smallest of these species (carapace length <8.5 mm), during *in situ* observations between 6 and 15 m depth on two maerl grounds in the Clyde Sea (Stravanan Bay 55°45.3301′N 05°4.2601′W and Creag Gobhainn 56°00.6001′N 05°22.2000′W) using SCUBA. *Galathea intermedia* were found in small groups, hiding in the interstices of maerl fragments or with up to three animals sharing the shelter of dead *Dosinia exoleta* (L.) shells. These bivalve shells were common on the sediment surface of the study sites having fallen prey to the starfish *Marthasterias glacialis* (L.) and *Asterias rubens* L. (J.M.H.-S., personal observation). A previously unrecorded feature of *G. intermedia* is its very conspicuous anterior coloration pattern consisting of six 'neon' blue spots in the frontal region of the head (a triangular epistomial patch medially above a small labral spot, a pair of lateral spots beneath the eyes at the base of the antennae and a pair of spots on the geniculate carpopodite of the second maxilliped endopodite).

Observations on the incidence of this coloration were made on 86 *G. intermedia*, with carapace lengths from 3.4 to 7.9 mm, measured from the tip of the rostrum to the posterior mid-dorsal margin. These animals were collected by removing maerl sediment and dead *Dosinia* shells from a 5 m^2 area at 10 m depth in Stravanan Bay on 25 September 1997. The squat lobsters clung to the collected substratum and few escaped. Previous UK records of *G. intermedia* show that it can be very common on gravelly sediments in the shallow sublittoral, with few records beyond 50 m depth (Marine Biological Association, 1957; Bruce et al., 1963; Crothers, 1966; Allen, 1967). The population density of *G. intermedia* recorded here on coralline gravel (at least 17 ind m^{-2}) is within the range of 3.0–16.6 ind per 0.25 m^{-2} encountered by Samuelsen (1970) at a similar depth (7–9 m) in Norway. He also found that this species was contiguously distributed with its abundance being positively correlated with the amount of coarse substratum.

When placed in aquaria, the squat lobsters hid amongst the shell/maerl substrata. Animals of various sizes settled near to one another with equanimity and began a routine of feeding and self-grooming (recorded using a Panasonic F10 video-camera (film rate 25 fields s^{-1}) fitted with a 50 mm Pentax macro-lens and connected to a Panasonic AG6200 video-recorder). The bright blue iridescent markings were strikingly apparent in *en face* view (Figure 1A). The largest and most conspicuous markings (visible *in situ* to the naked eye of divers) were on the carpopodite of the second maxilliped endopodite above due to limb flexure, but anatomically below a contrasting red/brown patch on the propodite (Figure 1A,B). These features are lost when the animals are fixed in alcohol or formalin, which probably explains why they have been overlooked in previous descriptions of the species (e.g. Liljeborg, 1851; Bouvier, 1940; Zariquiey Alvarez, 1968). The spacing and size of the markings increased with size of the animal but there were no obvious differences in their pattern or intensity depending upon the sex, maturity or egg-bearing status of individuals as this configuration of markings was present on all collected specimens. A few individuals moulted in captivity and the markings were seen before and after ecdysis.

Filmed observations in aquaria showed that *G. intermedia* used its chelae to tear food when presented with scraps of crab flesh but that scavenging was not its normal feeding mode, as shown with *G. squamifera* Leach, *G. strigosa* (L.) and *G. dispersa* Bate (Nicol, 1933). The ability of *G. intermedia* to detect carrion appeared to be limited, as scraps were ignored if lying beyond two body lengths from the animal. The animals fed primarily on detritus, sweeping fine particles from the substratum using the setose third maxillipeds and passing material on to the second maxilliped and thence to the mandibles. The highly reflective spots on the second maxilliped endopodites moved constantly as the animals fed or groomed the head region, this movement ceased when animals were disturbed with forceps and when conspecifics met.

Given the shallow-water and contagious distribution of *G. intermedia*, the highly reflective blue spots may have a function in communication. Their pattern and colour (or contrast in colour) may provide a means of intraspecific recognition

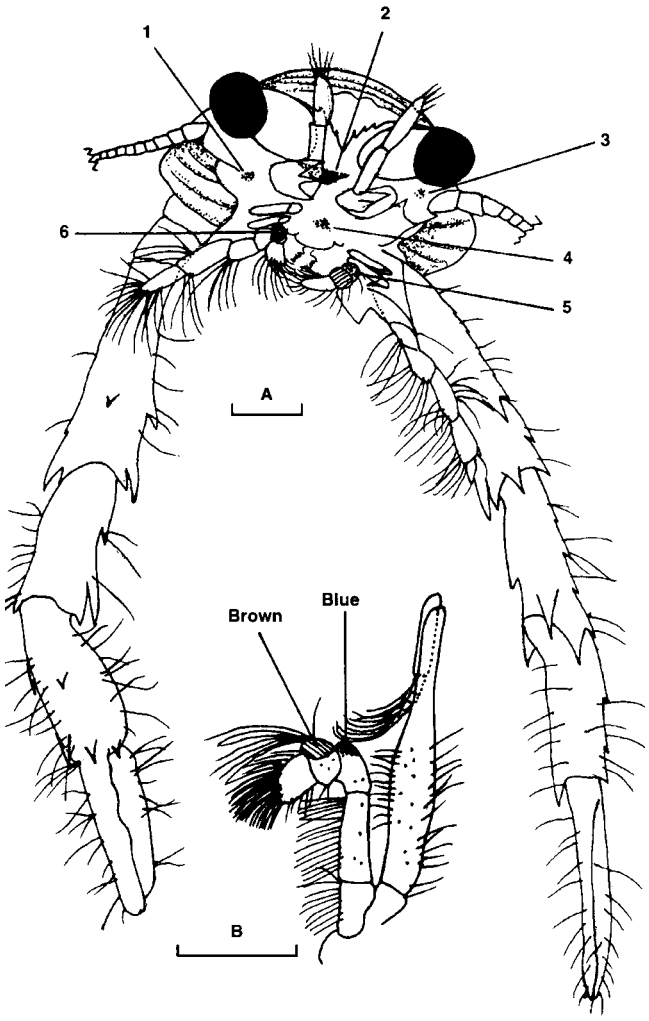

Figure 1. *Galathea intermedia*: (A) en face view (posterior thoracic limbs and abdomen excluded) with iridescent blue patches numbered 1 to 6; (B) left maxilliped 2 with brown (cross-hatched) and blue (stippled) patches indicated. Scale bars: 1 mm.

ensuring that shelters are only shared with conspecifics. Vannini & Gherardi (1981) demonstrated individual recognition in crabs and several studies have shown that markings influence interactions between crustaceans (e.g. patches on hermit crab claws, Dunham, 1978; meral spots in stomatopods, Hazlett, 1979). The distance between the spots may indicate size of an individual and therefore be important in agonistic interactions, where obtaining information on an opponent may influence whether to engage an opponent; and in affecting the outcome of a fight (Parker, 1974). In the hermit crab, *Calcinus laevimanus* (Randall), the size of the white patch on the enlarged left chela influenced the likelihood of winning a fight with crabs being more successful if they had a larger patch than their opponent (Dunham, 1978). Alternatively, these morphological traits may deter visual predators or play a role in sexual selection (see Kodric-Brown & Brown, 1984).

These preliminary observations have highlighted the need for more detailed behavioural study to elicit the function of these brightly coloured markings. Experimental investigation into the arrangement, colour, size and intensity of these spots and the role they play in communication (analogous to Crane's work (1949) on salticid spiders) would be of great interest.

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