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NOTE

Laboratory-induced spawning of the gastropod *Gibbula cineraria* as an indicator of field spawning

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ABSTRACT: The trochid gastropod *Gibbula cineraria* spawns in response to a rise in sea water temperature. A simple laboratory bioassay – a warm water stimulus – can therefore be employed to determine the competence of adult snails to spawn at any given time during the year. The bioassay has been used over 1 yr, at approximately monthly intervals, to establish the spawning season of a population of *G. cineraria* in NE England. The main spawning season was indicated between late June and early September. Spawning could also be induced in females in winter Results are discussed in relation to previous, contrasting, reports regarding the spawning season of *G. cineraria*.

Gibbula cineraria (L.) is gonochoristic and spawns directly to the sea where fertilisation occurs. Reports of the spawning season of *G. cineraria* present a confusing picture of events (see Underwood 1972 for a review). For example, Fretter & Graham (1962) consider that *G. cineraria* spawns throughout the year at Plymouth (SW England), while in Scotland (Elmhirst 1922) and North Wales (Thompson cited in Underwood 1972), spawning reportedly occurs in spring.

To clarify this situation, a laboratory study was performed using a simple and rapid bioassay (Clare 1987). The assay employs a 'warm water stimulus' and is based upon Underwood's (1972) observation that *Gibbula cineraria* spawns when the sea water temperature rises above 12 °C. The assay involves transferring 30 specimens, which have been maintained below 12 °C, to individual bowls containing 100 ml of sea water (also below 12 °C) and allowing them to equilibrate to room temperature (ca 20 °C). The bowls are examined after 24 h for spawned gametes and all snails are dissected to determine the condition of the gonad. The gonads are scored in 3 categories based on a visual examination. These categories are: (1) spent, i.e. the digestive gland is clearly visible through the gonad; (2) partly spent, i.e. patches of digestive gland are visible, and (3) gravid, i.e. the gonad is either entirely green in females or cream/white in males. This method allows the gonad condition to be rapidly evaluated.

The specimens used in this study were collected at low water from the intertidal zone at Cullercoats, NE England, throughout 1986 and during the early months of 1987. Fig. 1 shows the results of bioassays performed on the day of collection. Female snails had 2 potential spawning periods; one during the summer and the other during late winter. Male snails, however, spawned in response to a temperature rise in summer, but not during late winter.

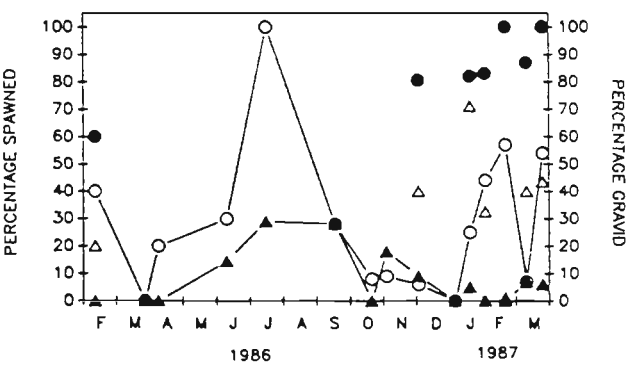

Fig. 1 *Gibbula cineraria*. Percentage spawning, induced by the warm water stimulus, over a 1 yr period. Gonad condition of dissected specimens is expressed as percentage gravid. (○–○) Female spawning; (▲–▲) male spawning; (●) ovary; (△) testis

These results suggest that successful spawning (i.e. resulting in fertilisation) occurs during summer (June to September) at Cullercoats when the sea water temperature is above 12 °C. This suggestion is borne out by the detailed study of Garwood (unpubl.) using the methodology of Garwood & Kendall (1985) and the

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observation that recruitment of spat occurs during September at Cullercoats (Garwood pers. comm.). Spawning by females may also be envisaged during the cooler months at Cullercoats, in particular on warm sunny days when the temperature of shallow water (e.g. in rock pools) may rise sufficiently to induce spawning. Certainly, a large proportion of the females are gravid at this time (Fig. 1). The data presented here, however, suggest that synchronous spawning by males is unlikely and, in consequence, spawned oocytes would not be fertilised. Even if fertilisation were to occur, it is doubtful that conditions suitable for complete larval development and subsequent settlement would prevail outside summer at Cullercoats. Indeed, there is no settlement of spat during the winter (Garwood & Kendall pers. comm.). Such conditions may be met toward the more southern limit of this species.

In summary, although female *Gibbula cineraria* are able to spawn during summer and winter, it is probably only during the summer spawning period that viable progeny result in northeast England. The presence of a putative spawning hormone in the cerebral ganglia of *G. cineraria* throughout the year (Clare 1987) presumably permits such 'out of season' spawning. In contrast, the related trochid *Gibbula umbilicalis* has a short spawning season (August) in southwest Scotland and the putative spawning hormone of this species is only detectable during this period (Clare 1986). Whether the warm water stimulus directly triggers the release of spawning hormone is unknown. The link between temperature and hormone release, however, is tenuous in males, since spawning can be induced in winter with extracts of cerebral ganglia, but not by the warm water stimulus (Clare 1987).

Bearing in mind the potential to spawn during most of the year, it is understandable that there are conflicting reports regarding the spawning season of *Gibbula cineraria*. Since it is well known that many other marine invertebrates spawn in response to temperature (Orton 1920, Kinne 1963, Underwood 1979), the warm water stimulus, or similar bioassay, may be useful in elucidating the spawning season(s) of some of these animals.

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