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Estimation of the size of onset of sexual maturity in *Nephrops norvegicus* (L.)

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Abstract

Size at onset of maturity (SOM) was estimated for both male and female *Nephrops* from primary sexual characteristics and morphometric traits. SOM estimated from primary sexual characteristics based on histological examination of the gonad ranged from 15.1 mm carapace length (CL) in males to 22.9 mm CL in females. *Nephrops* morphometric maturity, or change in allometric growth of body parts, was estimated from appendix masculina and cutter claw lengths in males and abdomen width in females from two sites in the Irish Sea. Two regression techniques were used to estimate morphometric maturity. Estimated SOM from morphometric characteristics ranged from 23.2 to 27.6 mm CL in females and from 25.9 to 31.0 mm CL in males. Spatial variation in SOM was observed in *Nephrops* from different parts of the Irish Sea.

Keywords: Appendix masculina; Morphometric maturity; *Nephrops norvegicus*; Primary sexual characteristics; Size at onset of maturity (SOM)

1. Introduction

The concept of age or size at onset of sexual maturity (SOM) is important in our understanding of the reproductive strategy and fitness of a species as a determinant of reproductive output. Benefits of earlier maturation include shorter generation times and higher survival to maturity as a result of shorter juvenile periods; organisms with delayed maturation benefit in terms of lower instantaneous rates of juvenile mortality and both higher initial and overall lifetime fecundity (Stearns, 1992). The ability to determine SOM is also important in the effective management of commercial fisheries, such as those for sympatric species of *Scylla* (Overton and Macintosh, 2002) and *Nephrops norvegicus* in that mesh sizes are normally set to reduce the capture of immature individuals (Tuck et al., 2000), which may improve stock recruitment and, in relation to maturity, contribute to the reproductive output of the stock.

Investigations of maturity in female and male *Nephrops* generally fall into two categories, histological and morphometric analyses. Histological techniques can be used to identify changes in the gonad and associated structures with maturity. Morphometric techniques describe changes in the relative growth rate (allometry) of body dimensions at the onset of sexual maturity (Tessier, 1960).

Although life-history theory defines age at maturity as the age of 'first birth' rather than the age at which some morphological or physiological criterion of maturity is met (Stearns, 1992), such criteria are widely used as best approximations of maturity for the purposes of both theoretical investigations and fisheries management. In addition, because crustaceans are notoriously difficult to age, size rather than age is the preferred parameter.

An early study identified the onset of sexual maturity in female *Nephrops* by measuring the carapace length of the smallest ovigerous female caught (Thomas, 1964). Thomas

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(1964) initially identified mature females as individuals with spermatophores present in the thelycum and found that size at first maturity varied around the Scottish coast. Farmer (1974a) considered that both gonad maturity and the presence of spermatophores should be used when assessing maturity. Thus, because a range of methods has been used to estimate SOM, data are not easily compared (Sardà, 1995). Morizur (1981, 1983) and Figueiredo (1982) suggested that the most accurate estimates of size at first maturity would be the size at which 50% of females display ripe ovaries and spermatophores, although they also mention that possible incidences of resorption of the ovary must be taken into account. Bailey (1984) investigated the size at which 50% of females were mature (L_{50}) based on a scale developed from macroscopic observations of the ovary colour and shape in the Clyde Sea area in Scotland. Farmer (1974b) examined the change in relative growth of abdomen width, at the second abdominal segment, in females from the Irish Sea and compared his findings with previous studies carried out in Scotland and England. Changes in abdomen width were associated with the carriage of eggs on the pleopods since an increase in abdomen width would provide more egg-carrying space. Tuck et al. (2000) investigated the change in allometry between abdomen width and carapace length of females collected from different sampling locations in the Clyde Sea area and found that carapace length at 50% maturity varied from 21 to 34 mm CL within areas only tens of kilometres apart.

Maturity in male decapods cannot be readily determined from macroscopic examination of gonads and associated structures, and few such studies have been documented. Storrow (1912) studied *Nephrops* in the North Shields area and concluded that the presence of spermatophores in the vasa deferentia was an indicator of sexual maturity. He found that males reached sexual maturity at 30 mm CL. Irish studies employing histological examination of male *Nephrops* from the Irish Sea found that the smallest individuals examined (17 mm CL) had spermatophores in the vasa deferentia. Estimates of the size at onset of maturity from morphometric characteristics are based on changes in the size of a part of the body, such as a chela, in relation to body size (Watters and Hobday, 1998). The inflexion point at which a change in relative growth occurs indicates the size at which males mature. Farmer (1974b) found that changes in the relative growth of the chela propodal length in males occurred at sexual maturity. Other allometric studies in *Nephrops* have included estimates of the relationship between body size (usually carapace length) and appendix masculina length (Hillis, 1977, 1981), number of segments on the antennule and both crusher and cutter claw propodal lengths (Tuck et al., 2000).

SOM in females has been used to establish minimum mesh size to avoid the capture of immature individuals for commercial fisheries (Tuck et al., 2000). This paper describes techniques to determine SOM in female and male *Nephrops*.

2. Materials and methods

2.1. Sampling

The Department of Agriculture and Rural Development for Northern Ireland (DARD) have performed spring and autumn trawl surveys aboard *RV Lough Foyle* since the early nineties to assess the state of *Nephrops* stocks in the Irish Sea. The data presented here are from recent DARD surveys. At each station (Fig. 1) a custom-made 36 m (20-fathom) *Nephrops* trawl net with a 50 mm mesh is deployed for approximately 1 h covering a distance of 2–3 nautical miles. The catch was sorted, *Nephrops* removed, weighed and carapace lengths measured. *Nephrops* sub-samples were then taken for morphometric analysis of body parts. Because peak abundance of females with mature ovaries in the catch occurs between July and September (Briggs et al., 2002) and because males have been shown to carry spermatophores in the vasa deferentia throughout the year (Farmer, 1974c), August was considered to be the most appropriate month in which to obtain samples to study maturity. During the 2000 summer survey a 2-m beam trawl with a 12 mm mesh was deployed and towed along the seabed for 5 min at each station to collect juvenile *Nephrops*. A pooled sample of such juveniles was made from all stations surveyed to investigate the size at onset of maturity from primary sexual characteristics (i.e. the condition of the gonad and contents of accessory ducts and chambers). Samples of small males and females were also collected and fixed in alcoholic Bouins solution to investigate the presence of spermatophores in the thelycum of females and in the vasa deferentia of males using histological techniques.

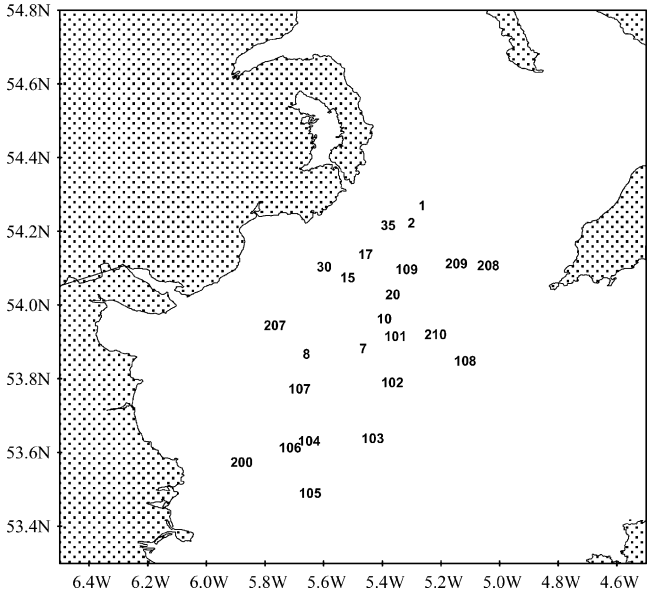

Fig. 1. Sampling stations in the western Irish Sea.