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Gonadal Maturity in Rajids
(Elasmobranch Fisheries – Poster)

by

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Abstract

A comparative analysis of morphological and histological maturity was conducted on a representative sub-sample of 98 individuals from a total database of 538 specimens of the spotted ray, *Raja montagui*. At a histological level maturity, defined by the presence of spermatozoa in the testes, was achieved by males at a smaller size than functional maturity, described by current maturity scales. Morphological evidence indicates that nidamental gland width, in females and clasper length, in males, are reliable indicators of maturity in *R. montagui* when related to total length and the physiological histology of the testes. On the basis of these results the development of an objective measure of maturity for rajids is both possible and practical using these structures. In addition, these measurements provide finer resolution of the process of maturation during the life history of both sexes, without a significant increase in data collection effort. A greater degree of reliability than that provided by the partly subjective nature of current, maturity scales is therefore possible, permitting an improvement in the user confidence of rajid maturity data, for fisheries management purposes.

Introduction

The confident assessment of maturity is an essential prerequisite/component of an appropriate and effective fishery management plan (Martin and Zorzi, 1992). Traditionally the maturity stages of rajids have been assigned on the basis of the external morphology of the claspers and gonadal development stage in males and the internal, gonadal development stage of females (Stehmann, 1987). The development process of the clasper, is species specific and may exhibit/represent an abrupt or gradual transition in size with maturity (Pratt, 1979). The assignment of maturity on the basis of morphological measurements of the gonads, particularly the nidamental gland, in females has been shown to be a valid method for the determination of the onset of maturity (Ellis and Shackley, 1995). Once mature the gonads of rajids continuously produce reproductive gametes. Adults are theoretically capable of spawning year round in addition to temporally localised peaks in spawning activity (Richards *et al*., 1963; McEachran, 1970; DuBuit, 1976; Brander and Palmer, 1985) although seasonal clasper resorption has been reported for some species (Ryland and Ajayi, 1984). These differences in reproductive cycles between species, and in some cases between different populations of the same species advises caution in the application of gross estimates of maturity and suggests the need for a cautious and objective approach in the assignment of maturity (Wourms, 1977). The development of confidence in the use of maturity scales demands an unambiguous understanding of the maturation process using histological techniques. The relationship of specific sexual condition to an assigned morphological maturity stage forms the subject of this study.

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Materials and Methods

A total of 538 specimens of the spotted ray, *Raja montagui*, were collected from the landings of commercial fishing vessels at the Irish east coast port of Howth, over a period extending from August 1996 to February 1998. The total length (nearest 0.5 cm below) and sex was recorded for each specimen and a morphological maturity stage assigned using a standard maturity scale (Stehmann, 1987). In addition, clasper length (mm) in males and maximum nidamental width (mm), in females was recorded. The testes of 89 male specimens representing all stages of morphological maturity were excised in their entirety and fixed in 10% formaldhyde. Sections of each testis were embedded in paraffin wax following alcohol dehydration (2 hours at 50%, 70% 96% and Absolute ethanol) and clearing in xylene. Section of 8µm to 10µm were floated onto the surface of a bath containing Mayer's albumen (10 drops/l) and mounted on glass slides and placed on a hot plate to dry overnight. Sections were subsequently stained with haemotoxylin and eosin, mounted using a clear mounting medium (DPX) and cover slip and examined under x40 and x100 magnification. The relative abundance of spermatogonial, spermatocytic, spermatid and spermatozoal ampullae were counted along a transect running from the ventral, ampullogenic zone of the testis to the dorsal surface. Specimens were determined to be mature if testicular sections contained spermatozoal ampullae.

Results

On the basis of the morphological determination of maturity, maturity ogives were constructed for male (N=274) and female (N=175) individuals (Fig. 1). Lengths at 50% maturity were determined to be 53.65 cm total length for males and 57.44 cm total length for females.

The relationship between clasper length and total length in males (Fig. 2) and nidamental gland width with total length in females (Fig. 3) displayed a point of inflection about the pre-determined point of 50% maturity.

The relative abundance of spermatogonial, spermatocytic, spermatid and spermatozoal ampullae in testes examined histologically (Fig. 4) indicated a length at maturity of 45.0 cm total length. Morphologically assigned immature individuals were characterised by the presence of spermatogonia and spermatocytes in the lower part of their range and thereafter by the presence of spermatogonia, spermatocytes and spermatids. Maturing individuals showed a similar developmental progression with spermatozoa present in the larger individuals classed at this stage. Fully mature specimens were found in all seasons throughout the sampling period and were characterised by the complete range of developmental stages and spermatozoa.

Twenty one individuals, representing 68% of those classified as adolescent maturing and characterised by flexible claspers and incomplete structure of the glands, contained spermatozoa within the testes (Table 1).

Discussion

The analysis of histological and morphological maturity in male and morphological maturity in female *R. montagui* indicates that the process of maturation is both gradual and progressive. At the onset of maturity, the claspers of the males and the nidamental glands of the females is defined by a rapid increase in size of these organs, with individuals reaching 50% maturity at ages estimated to be of 3.4 years and 4.1 years, respectively (Gallagher, 2000). Mature spermatozoa, occurring in males with incomplete cartilage development of the claspers, indicates that histologically determined, physiological maturity occurs at a smaller total length than functional maturity. Physiological and functional maturity were separated by 9.0 cm in total length at 45.0 cm and 54.0 cm, respectively, representing a period of growth extending over an interval of 16 months (Gallagher, 2000). The imposition of a fixed and subjective maturity scale, which categorises males on the basis of morphological maturity on a process, which is inherently continuous and subject to environmental fluctuation was apparent. A relationship between histological maturity and external clasper morphology is evident and occurs at the point of inflection, at which the rate of growth of the clasper increases rapidly to the point of developmental stasis. A similar relationship exists between nidamental gland width and total length.

Morphological evidence indicates that nidamental gland width, in females and clasper length, in males, are reliable indicators of maturity in *R. montagui* when related to total length and the physiological histology of the testes.

On the basis of these results the development of an objective measure of maturity for rajids is both possible and practical using these structures. In addition, these measurements provide finer resolution of the process of maturation during the life history of both sexes, without a significant increase in data collection effort. A greater degree of reliability than that provided by the partly subjective nature of current, maturity scales is therefore possible, permitting an improvement in the user confidence of rajid maturity data, for fisheries management purposes.

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Table 1. The frequency of occurrence of spermatogonia, spermatocytes, spermatids and spermatozoa in testicular sections from the spotted ray *R. montagui* (N=89).

Morphological maturity stage	Spermatogonia	Spermatocytes	Spermatids	Spermatozoa
1	26	22	12	0
2	31	31	31	21
3	16	16	16	16
4	16	16	16	16
Total	89	85	75	53

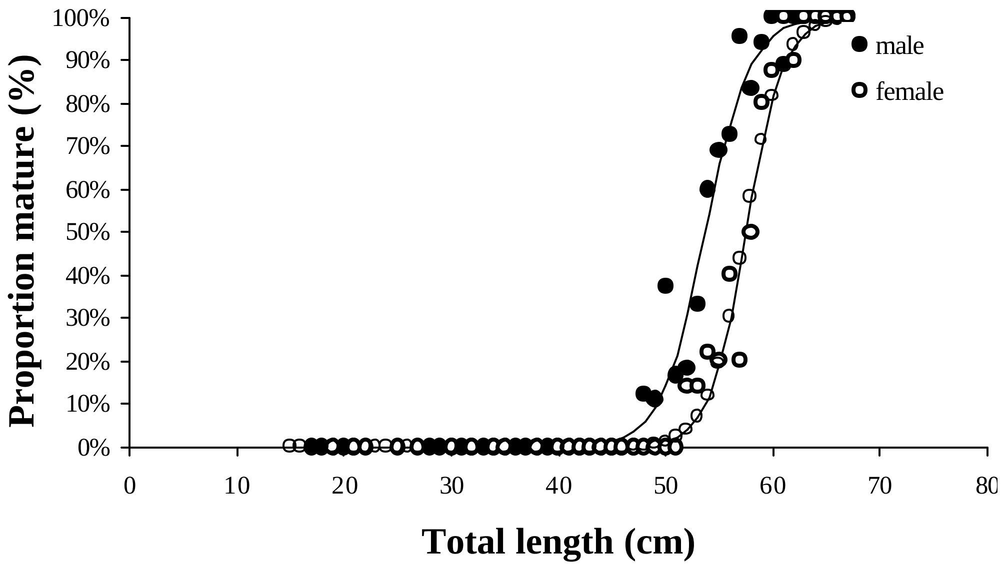

Fig. 1. Maturity ogives for male (?) and female (?) *R. montagui*.

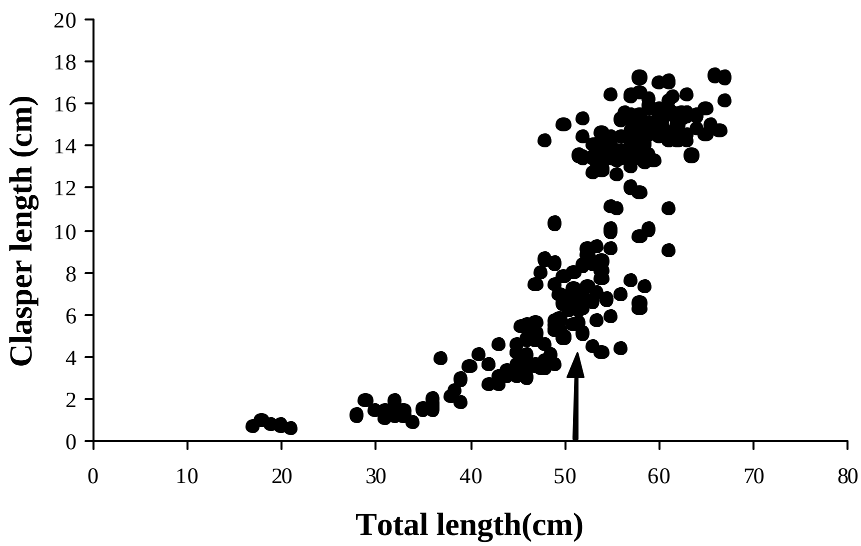

Fig. 2. The relationship between clasper length and total length in male *Raja montagui*. The total length at 50% maturity (53.65 cm), determined from maturity ogives generated from the morphological assessment of maturity is indicated by an arrow (N=273).

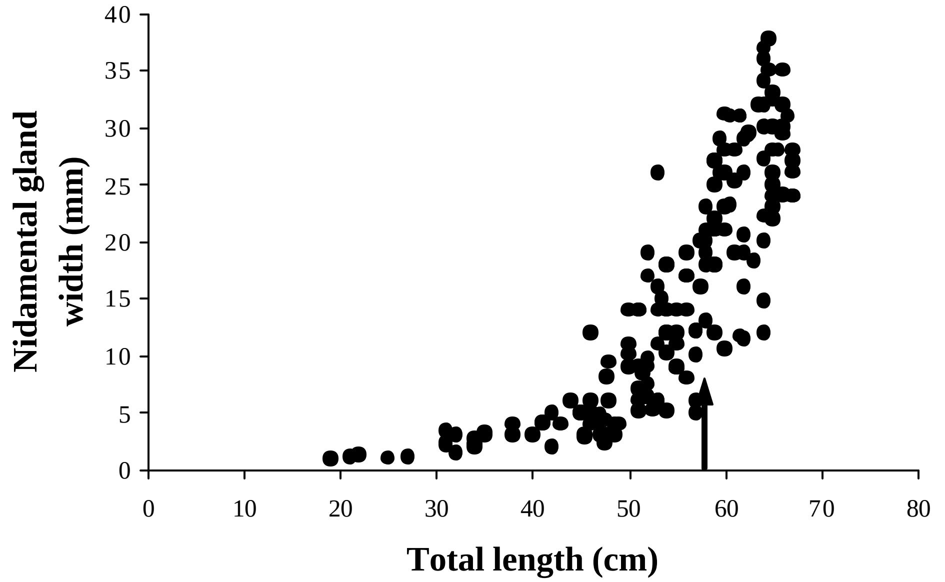

Fig. 3. The relationship between nidamental gland width and total length in female *Raja montagui*. The total length at 50% maturity (57.44 cm), determined from maturity ogives generated from the morphological assessment of maturity is indicated by an arrow (N=194).

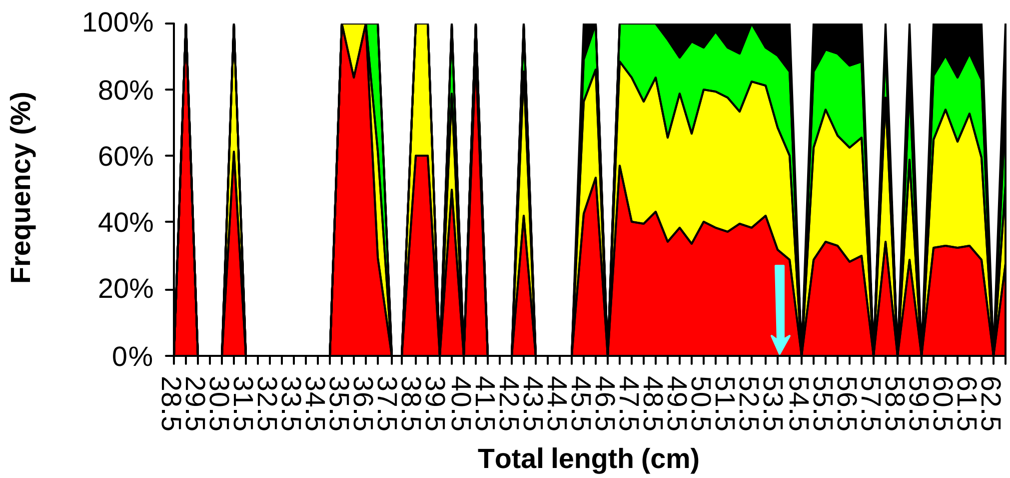

Fig. 4. The relative abundance of spermatogonial (red), spermatocytic (yellow), spermatid (green) and spermatozoal (black) ampullae expressed as a function of length (cm) from counts made along transects of testicular sections from the spotted ray *R. montagui*. Length at 50% maturity, assigned morphologically, is indicated by a vertical arrow at a total length of 53.65 cm (N=89).