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BRIEF COMMUNICATIONS

Sexual dimorphism in morphometric characteristics of cocktail wrasse

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A closely associated set of characteristics was identified in adult cocktail wrasse *Pteragogus aurigarius*, collected in a coastal area on Cheju Island, Korea in 1993, which showed sexually dimorphic growth. Growth was positively allometric in males. Male cocktail wrasse possess larger first and second spinal rays in the dorsal fin than females resulting in pronounced sexual dimorphism. Such sexual dimorphism may reflect the outcome of sexual selection in this species.

Key words: *Pteragogus aurigarius*; sexual dimorphism; morphometric characteristics.

Protogyny is known in 14 families of fishes, 11 of which inhabit coral reef areas (Policansky, 1982). The wrasses (Labridae) comprise a large and well-known family of coral reef fishes that exhibit sequential hermaphroditism (Warner, 1984). The cocktail wrasse *Pteragogus aurigarius* (Richardson) is a Far East Continental-endemic species and inhabits the coastal waters of Cheju Island in Korea, and the sea off Japan (Jordan & Snyder, 1902; Nakazono, 1979; Lee *et al.*, 1992; Yoshino *et al.*, 1998). In a previous study Lee *et al.* (1992) reported sexual dimorphism in cocktail wrasse at Cheju Island, on the basis of protogynous hermaphrodites. Body colour changes and rapid growth in the first and second spines of the dorsal fin accompany the change from females to males at spawning (Lee *et al.*, 1992). However, there is no indication of how common sex change might be in this species, since few studies have been investigated carefully. The purpose of the present investigation was to examine the allometric growth patterns of several morphometric characteristics, including those used commonly to distinguish sexes of cocktail wrasse, and to assess their effectiveness in discriminating between males and females.

From April to October 1993, cocktail wrasse were collected by longlines near Cheju Island, Korea. Measurements were taken (to the nearest 0·1 mm) with vernier callipers from freshly sampled individuals. Sixteen measurements were recorded (Fig. 1) including: standard length (L_S), horizontal distance between the anterior edge of the upper lip and the anterior insertion of first anal fin (HALAA), head length (HL), direct distance between the anterior edge of the upper lip and the anterior insertion of the first ventral fin (DALAV), direct distance between the anterior edge of the upper lip and the anterior insertion of the first anal fin (DALAA), direct distance between the anterior edge of the upper lip and the posterior insertion of the last anal fin (DALPA), direct distance between

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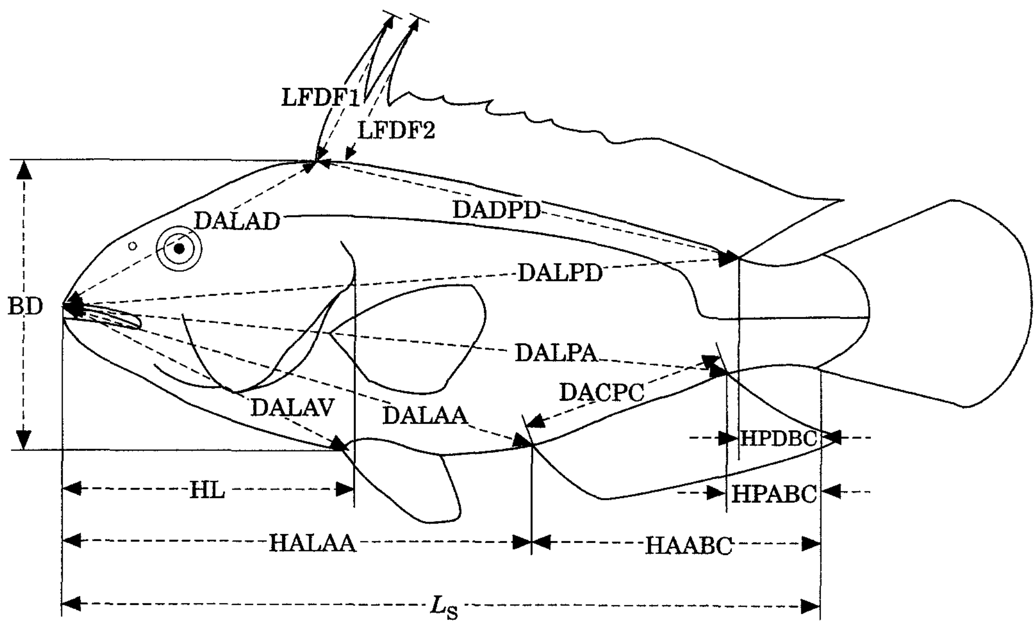

FIG. 1. Morphometric measurements of cocktail wrasse used in this study. For abbreviations see text.

TABLE I. Mann–Whitney U-tests for differences in 15 body measurements and standard length (L_S) between sexes in cocktail wrasse

Characteristic	U	Probability	
HALAA	4664·5	0·0434	*
HAABC	4699·5	0·0339	*
DALAV	3987·0	0·9516	NS
HPABC	4636·0	0·0527	NS
HPDBC	4547·0	0·0930	NS
BD	4210·0	0·4805	NS
DALAA	4852·5	0·0104	*
DALPA	4127·5	0·6405	NS
DALPD	4188·5	0·5200	NS
DALAD	4203·5	0·4923	NS
DADPD	4643·0	0·0503	NS
PACPC	3983·5	0·9596	NS
LFDF1	7644·0	0·0000	***
LFDF2	7438·5	0·0000	***
HL	4307·5	0·3235	NS

The sample numbers of females and males are 77 and 103, respectively. For abbreviations see text. *P<0·05; **P<0·01; ***P<0·001; NS, not significant.

the anterior edge of the upper lip and the posterior insertion of the last dorsal fin (DALPD), direct distance between the anterior edge of the upper lip and the anterior insertion of the first dorsal fin (DALAD), body depth (BD), length of the first fin ray of the dorsal fin (LFDF1), length of the second fin ray of the dorsal fin (LFDF2), direct distance between the anterior insertion of the first dorsal fin and the posterior insertion of the last dorsal fin (DADPD), direct distance between the anterior insertion of the first caudal fin and the posterior insertion of the last caudal fin (DACPC), horizontal distance between the posterior insertion of the last anal fin and the base of the caudal fin (HPABC), horizontal distance between the posterior insertion of the last dorsal fin and

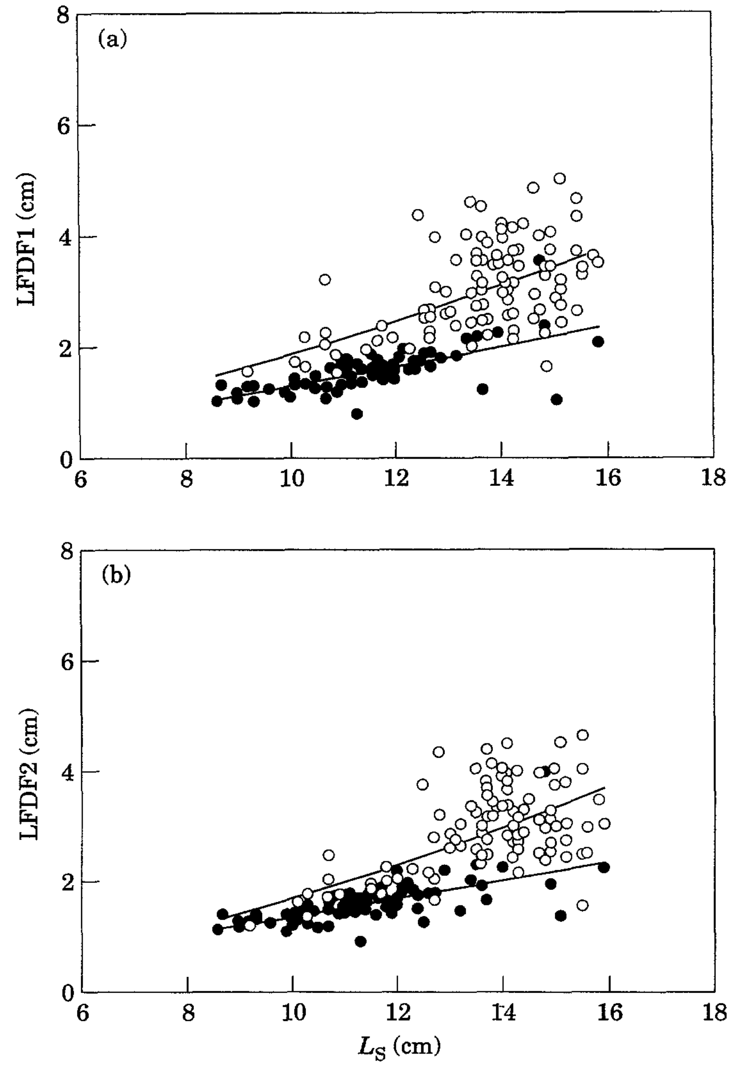

FIG. 2. The relationship between standard length and (a) first spinous ray of dorsal fin (LFDF1) and (b) second spinous ray of dorsal fin (LFDF2) for female (●) and male (○) cocktail wrasse. (a) Female LFDF1=0·0667$L_S^{1·2878}$, r^2=0·470; male LFDF1=0·0603$L_S^{1·4909}$, r^2=0·357; (b) female LFDF2=0·0941$L_S^{1·1588}$, r^2=0·461; male LFDF2=0·0353$L_S^{1·6796}$, r^2=0·418.

TABLE II. Comparison between male and female log–log regression coefficients of the first spinous ray (LFDF1) and second spinous ray (LFDF2) of the dorsal fin and standard length (L_S) for cocktail wrasse

	n	Differences between intercepts		Differences between slopes	
		Student's *t*	*P*-level	Student's *t*	*P*-level
LFDF1	129	10·8485	<0·001	0·7867	NS
LFDF2	129	8·9536	<0·001	2·0864	<0·05

the base of the caudal fin (HPDBC), and horizontal distance between the anterior insertion of the first anal fin and the base of the caudal fin (HAABC). Sex and maturity of each individual were determined as described by Lee *et al.* (1993) using external morphology, body colour, internal gonad inspection and gonad squash preparations.

The Mann–Whitney *U*-test (Zar, 1984) was used to compare the 15 measurements with standard length by sex. After log transformation, each measurement was regressed with the log standard length by sex. Regression coefficients were compared between sexes by ANCOVA (Zar, 1984).

During the sexual maturation period, June and July, changes in L_S were observed in males, but were less in females. Lee *et al.* (1992) reported that when the water temperature began to rise, the gonadosomatic index of cocktail wrasses began to increase in May for males and June for females reaching maximum values in June for males and in July for females.

The relationship between five morphometric characteristics, HALAA, HAABC, DALAA, LFDF1 and LFDF2, was significantly different between sexes, in particular LFDF1 and LFDF2 which were highly significant ($P<0{\cdot}001$) (Table I).

The regressions of LFDF1 and LFDF2 were significantly different between sexes ($P<0{\cdot}001$) (Fig. 2, Table II). However, only the slope of the LFDF2 regression and L_S differed significantly between sexes ($P<0{\cdot}05$) (Table II). In male cocktail wrasse, changes in the first and second spiny rays of the dorsal fin are more pronounced in the breeding season and are not present in sexually immature fish. Sexual dimorphic characterics in fish structure have been noted in other fishes (Iguchi *et al.*, 1991; Oliveria & Almada, 1995).

Lee *et al.* (1992) found body colour changes in protogynous bagridae. The body colours of *Halichoreres poecilopterus* Temmenck & Schlegel and *P. aurigarius* changed by sex reversal from pale red or yellow lines to brilliant green or dark yellow lines. Secondary sexual male characteristics as in cocktail wrasse, are often considered to have evolved through sexual selection to promote success in male–male competition or female choice. It is not possible at present to explain why cocktail wrasse males have longer first and second spiny dorsal fin rays compared to females, because the functional role of spines in reproduction is unknown.

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