

## Courtship and Spawning of Nine Species of Wrasses (Labridae) from the Western Pacific

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**Abstract** Courtship and spawning behaviors for the Western Pacific wrasses *Cheilinus fasciatus*, *Choerodon fasciatus*, *Cirrhilabrus cyanopleura*, *C. katherinae*, *Oxycheilinus unifasciatus*, *Pteragogus cryptus* and *Thalassoma amblycephalum* are described. Pair spawning was observed in six species and group spawning in *T. amblycephalum*. Mating systems included harem mating groups, promiscuity, lek-like behavior leading to group spawning, and facultative monogamy. Observations of some courtship behavior of two additional species, *Cheilinus undulatus* and *Epibulus insidiator*, indicated parading by mating group members in the former, and patrolling by males in the latter. The distinct behavioral patterns observed may have use in future phylogenetic analyses and in determining paths of evolution in the behavior of these fishes.

The wrasses (Labridae) are a remarkably large and diverse group of tropical and temperate marine fishes distributed on coral and rocky reefs and sand flats throughout most of the world. Currently, 57 genera and approximately 500 species are recognized (Nelson, 1994). Their reproductive behavior has been the subject of considerable interest (e.g., Robertson, 1981; Thresher, 1984; Colin and Bell, 1991; Moyer, 1991). Still, much needs to be learned of their reproductive behavior and the potential for geographic variation within species (Colin and Bell, 1991; pers. obs.). This is particularly true before phylogenetic analyses of behavioral and ecological relationships among species, and tracing the historical pattern of the evolution of behavior within the family, can be attempted (Brooks and McLennan, 1991).

During the course of other studies I was able to observe courtship and spawning behavior of nine species of wrasses at different localities in the Western Pacific. I report these observations here and, where pertinent, provide comparisons for a few species, *Cheilinus fasciatus*, *Oxycheilinus* (formerly *Cheilinus*) *unifasciatus*, *Epibulus insidiator*, and *Thalassoma amblycephalum*, whose courtship behavior differs somewhat from that reported elsewhere (Colin and Bell, 1991).

### Materials and Methods

Observations were made using scuba. Notes were recorded on underwater paper, and were augmented in some instances by underwater still photography. Species identifications follow Masuda et al. (1984), Myers (1989), Randall et al. (1990), Kuitert (1992), and Westneat (1993) where appropriate. Descriptions of behavior patterns follow Colin and Bell (1991) and Moyer (1991). Body size (cm TL) was estimated *in situ* with a metric rule placed against a landmark (coral pillar, rock, ledge, substratum etc.) where a fish had just passed (e.g., Donaldson, 1990; Clark et al., 1991). Sex was presumed from differences in relative size (male > female) and behavioral roles (e.g., Colin and Bell, 1991; Moyer, 1991). Since observations were often made incidental to other studies, and at various times of the day, individual descriptions of localities, sites, physical parameters, courtship, and spawning behavior by species are presented.

### Results

#### *Cheilinus fasciatus*

Courtship and spawning were observed on 3 Octo-

ber, 1992 at Kayangel Atoll, Palau Islands. The tide was ebbing and the moon was one day prior to first quarter. The courtship site was located at a fork in the main channel inside the lagoon. Water depth in the center of channel was about 9 m. An oblong-shaped coral promontory rose about 4 m above the substratum at the center of the fork. The top supported a dense thicket of *Acropora* sp. coral and heads of various other species. This structure served as a rendezvous site (e.g., Moyer, 1991) for courtship and spawning activities.

At 15:00, a male *C. fasciatus*, ca. 23 cm TL, patrolled around the promontory. Patrolling consisted of swimming slowly, high in the water column, ca. 1.8–2.4 m above the promontory, in wide irregular circles. The male's dorsal and anal fins were depressed towards the caudal fin, which was folded. Colin and Bell (1991) reported the same pattern for this species and for *Epibulus insidiator* at Enewetak. Swimming was accomplished principally by movement of the pectoral fins. Occasionally, the male descended to the promontory, circled it partially or completely, and then returned to the water column.

At about 15:05, a female (No. 1) swam up from the *Acropora* coral thicket and into the water column directly over the center of the promontory but below the circling male. Soon, additional females arrived at the promontory from various directions and hovered at different positions just above the promontory (Table 1). The male continued to circle the promontory, well above the females, as they arrived. Occasionally, he made forays of up to 15 m away from the promontory, his head angled upwards, as if searching for females that had not yet arrived. This behavior ceased after the 7th female arrived at 15:30. No aggressive interactions occurred between

females.

At about 15:37, the male approached female No. 5 and began courtship. High in the water column, the male began to tighten the radius of his circles as he centered in on the hovering female. Occasionally, body shaking by the male was observed. As the male approached, the female very slowly began to rise in the water column and started circling, with her body tilted slightly to one side. The male responded by accelerating towards the female and bobbing his head as he began swimming in an exaggerated zig-zag pattern which gradually became a short series of S-shaped curves. Head bobbing continued until the female joined him. The two then briefly swam parallel to one another before rising quickly into the water column. On some occasions, the pair would bob up and down together while executing a quick circle before beginning to rise. During the ascent, the male pushed slightly against the anterior portion of the female's flank. At the apex of the rise, some 2 m above the starting point, the pair quickly turned, their bodies twitching briefly. A small cloud of gametes was clearly seen. The female rapidly descended to the substratum, and the male continued to patrol until courtship began with the next female.

Courtship and spawning was sequential, but there was no significant positive correlation between spawning order and female arrival order (Kendall's  $\tau = -0.524$ ,  $p = 0.099$ , 2-tailed test) or female body size (Kendall's  $\tau = 0.619$ ,  $p = 0.051$ , 2-tailed test; Table 1). The amount of time spent courting and spawning (6 min: 15:37–15:43) was relatively short compared to that spent in pre-courtship patrolling (>37 min), and all spawns were completed between 15:38–15:43 (Table 1).

### *Cheilinus undulatus*

This is the largest species of wrasse and very little is known about its behavior. At Sasanhaya Bay, Rota, I frequently observed a social group consisting of a single male (ca. 170 cm TL) and five females (ca. 25–110 cm TL) just prior to sunset (15–20 October, 1990, sunset 18:01–18:02, tide flooding, moon approaching 4th quarter; 6–8 May, 1991, sunset 18:37–18:38, tide falling, moon in first quarter; 6–13 July, 1991, sunset 18:52–18:51, tide falling then flooding, moon between first quarter and new).

The group "paraded" down current in single file along the edge of the reef slope where *Porites rus* terraces bordered deep sand flats at 30–33 m. The

**Table 1.** Body size, time of appearance at courtship site, and time of spawning (to nearest minute) of female *Cheilinus fasciatus* at Kayangel Atoll, Palau Islands. Rank orders are given in parentheses

Female number	Body size (TL cm)	Time of appearance	Time of spawning
1	12 (5)	15:00 (1)	15:42 (6)
2	11 (6)	15:00 (2)	15:43 (7)
3	10 (7)	15:15 (3)	15:39 (5)
4	14 (4)	15:20 (4)	15:39 (3)
5	16 (1)	15:20 (5)	15:38 (1)
6	14 (3)	15:30 (6)	15:38 (2)
7	15 (2)	15:30 (7)	15:39 (4)

parade was usually 10–15 m above the substratum, and occasionally, turned into the current and proceeded in the opposite direction toward Puna Point, if the current was flowing westward. Normally, the male led the parade, but occasionally one of the females would, with the male following in fourth or fifth position. Similar behavior has been observed at the reef channel between Kuroshima and Taketomi islands, in the Yaeyama Islands of Japan (J. T. Moyer, pers. comm.). I have not seen further courtship or spawning but suggest that it is sequential in a harem system.

#### *Choerodon fasciatus*

Courtship was observed on two evenings, 25–26 November, 1986, at North Point, Lizard Island, Great Barrier Reef, Australia. Pair spawning was observed on the evening of 25 November. The pair was sexually dimorphic in body size. The male measured ca. 25 cm TL and the female ca. 17 cm TL. Spawning occurred on the outer edge of the fringing reef, an area that experienced strong tidal currents. Water depth was approximately 9 m and the temperature was 28°C. The tide was ebbing and the moon was in last quarter. The pair was distinguished subsequently by recognition of minor color pattern variations and relative size of both individuals, and by association with the same location on the reef.

I observed the same pair over a period of three weeks, between 19 November–6 December, at various times of the day. No other conspecifics were observed in the area. Usually, the pair swam slowly along about 100 m of the reef's face. They stopped to explore holes, crevices and the underside of overhanging ledges. Frequently, the male led the female during these swims. Occasionally, the pair would separate for a few minutes, usually while feeding, but pair formation would resume afterwards.

Prior to the onset of courtship, the pair swam, either side by side or with the female slightly in the lead, back and forth along a portion of the face of the reef that turned a corner (about 70 deg.) relative to face. At about 18:31, the pair hovered and, parallel to one another with their bodies close together, circled a few times about 5 m above the substratum before rapidly ascending another 2 m into the water column. At the apex of the ascent, the pair turned downward and released a small, milky cloud of gametes. Time of spawning was 18:32, or 1 min past sunset. Immediately afterwards, the pair swam

quickly to the bottom and out of sight.

#### *Cirrhilabrus cyanopleura*

Courtship and spawning was observed briefly at the north side of the Tochelir Ra Ngebard reef passage, northern Palau Islands, during the afternoon (15:20–15:40) of 29 September, 1992. Males patrolled the area, and circled and rushed in the water column above coral pillars and knolls that rose from the substratum (12–13 m deep) of the terrace just below the forereef. Numerous (>25) females hovered or swam slowly in the vicinity of four males, and each male made repeated approaches to females while flashing iridescent colors. Spawns were paired, rapid, and began with a quick rush by the male toward the female, with only short ascents (ca. 1.0–1.8 m) into the water column. Gamete clouds were visible after each spawning ascent. Males made multiple spawns, and courtship continued until the end of my observation (16:10). The tide was flooding, and it was three days past the new moon.

#### *Cirrhilabrus katherinae*

This species has recently been described by Randall (1992), and is sexually dichromatic. Courtship and spawning was observed at Rota (see *Oxycheilinus unifasciatus* below for details of the site) on 27 May, 1992, between 15:30–16:00. Three males and approximately 40 females were observed moving slowly in a group above the slope about 3–5 m above the substratum. Depths ranged from 20–23 m at the site.

Males did not seem to utilize physical features of the reef, nor defend any areas of the water column. While the group moved, males patrolled around the area, passing back and forth in front of individual females, and occasionally circling them while bobbing their heads. Male dorsal fins were fully erect, and males occasionally “flashed” females (see Bell, 1984) and “turned on” their bright color patterns (see Myers, 1989). Just prior to spawning, a single male circled an individual female tightly, dorsal fin erect, and the pair quickly assumed positions parallel to one another, with the male slightly behind the female, before making a rapid short ascent into the water column. Spawning occurred at the apex of the ascent, and then the male quickly approached the other females to repeat the process. A gamete cloud was seen after each ascent. Streaking by other males

was not observed though other males were close by. Spawning continued past 16:00.

The tide was flooding, and a detectable current was running parallel to the reef slope at the time of spawning. Gametes were carried with the current. The moon was four days past the last quarter.

### *Epibulus insidiator*

Courtship, but not spawning, was observed at the north side of the Tochelir Ra Ngegard reef passage, northern Palau Islands, on the afternoon (15:30–15:40) of 29 September, 1992 (see *C. cyanopleura*, above for details of the site). Large (18–23 cm TL) males were observed patrolling high in the water column above prominent landmarks, usually coral pillars, large boulders, or knolls. Males and females were clumped around such landmarks, and these structures likely serve as rendezvous sites. Patrolling males were within visual contact of one another.

During patrolling, males swam slowly, their dorsal and caudal fins depressed (the latter pointed upward), and the anal fin extended. Colin and Bell (1991) have described this same pattern from *E. insidiator* at Enewetak. Patrols consisted of slowly swimming irregular circles 2–4 m above the landmark. Females generally hovered or swam slowly close to the substratum. Occasionally, a bobbing motion was observed when a female rose slowly into the water column near a male.

Male color pattern was similar to that described by Colin and Bell (1991), except that most of the body appeared almost black while the dorsal portion behind the head was a bright orange-red. Female color patterns ranged from brown, to tan, bright yellow, black, or black with a pronounced yellow spot just below the dorsal fin. Larger females were either tan or bright yellow.

### *Oxycheilinus unifasciatus*

Courtship and spawning was observed at Rota, Northern Mariana Islands, on 29 May, 1992, between 10:25–10:30. The tide was falling, and the moon four days past the last quarter. The courtship site was located just NE of the harbor entrance on the top of a reef slope at a depth of 13 m. A single harem mating group was present. Individual members had been observed in the area over the previous three days. The male (ca. 25 cm TL) patrolled an area of approximately 400 m<sup>2</sup> along the edge and out

in the water column some 10–13 m above the substratum. Three females (No. 1: ca. 18 cm TL; No. 2: ca. 21 cm TL; No. 3: ca. 17 cm TL), which earlier had been foraging along the bottom, slowly rose in the water column and hovered, at approximately the same depth, above the outer edge of this area. During patrols, the male slowly swam about the area, for at least 8–10 min, in ever widening circles away from the edge until reaching each of the females, each of whom he visited briefly before going on to the next. Each female was visited more than once during this time period. The male's swimming was accomplished, for the most part, with his pectoral fins, while dorsal and anal fins were depressed and the caudal fin occasionally extended. During each visit, the male circled the female and then departed. As the visits increased in frequency, the circles tightened.

This species demonstrated an ability to rapidly change color pattern while foraging, when approached by divers, and during social and mating interactions. The male's color pattern had normally been dark brown or grey with pale rose vermiculations on the edges of scales, a pronounced white bar bordering the caudal peduncle, and a faint pale colored lateral stripe (see Myers, 1989: pl. 91f). During courtship, this pattern changed to dark grey dorsally and white ventrally, with a distinct pale-colored eyebar that joined the lateral stripe. Females, normally mottled in brown and white shades, turned mostly white, with a only some brown, mainly the lateral bar, remaining. They also developed a pronounced grey-brown bar across the snout and eye, which extended back to the posterior portion of the operculum. Temporary sexual dichromatism has been reported previously for this species (Fourmanoir and Laboute, 1976; Colin and Bell, 1991), although the colors reported previously differ somewhat from my own observations.

Just prior to spawning, the male approached a female sequentially (No.1, followed by Nos. 2 and 3), his head lowered about 25–35 deg, and circled her as she very slowly began to rise in the water column. Mutual circling was followed by posing by the male, in which dorsal and anal fins were greatly contracted and the caudal fin extended. The male then approached the female's flank. The female turned parallel to him, and they began to swim together for a few cm before turning upwards to make the spawning ascent. The ascent began slowly but accelerated rather quickly, with the pair rising nearly 7 m above

their starting point. At the apex of the rise, the pair turned downward and a small cloud of gametes appeared. The descent was rapid as the male turned away from the female, returned to the approximate depth from which the ascent began, and resumed circling the area, first widely, and then narrowly as approached the next female and repeated the process. Once spawning commenced, all bouts were completed within 5 min. Members of the group swam back towards the substratum after completing their reproductive activities and were observed swimming and foraging around the area afterwards.

#### *Pteragogus cryptus*

Courtship and spawning of a single pair was observed at Kayangel Atoll, Palau Islands, on the afternoon of 3 October, 1992. The courtship site was the same promontory as that described above for *Cheilinus fasciatus*. Both individuals had assumed a dark brown color pattern without the white markings normally seen on this species (see Myers, 1989: pl. 94H).

At about 15:30, the pair emerged from the coral thicket atop the promontory and hovered just slightly above and outward from the edge of the coral. The promontory appeared to function as a rendezvous site. Hovering was accomplished by slowly drifting up and down in the water column, but never more than 0.5 m above the coral. The male (ca. 7 cm TL) was always higher in the water column than the female (ca. 6 cm TL), and the latter occasionally drifted down to the level of the coral before rising slowly again. By 15:35, the male began to swim back and forth above the female in a zig-zag pattern (cf. "sway swimming" in a congener, *P. flagellifera*; Moyer, 1991). At the end of each pass over the female, the male executed a hard upward tilt, followed by a sharp dip downwards, and then turned to continue the zig-zag pattern. The female twice rose in the water column toward the male, only to drift back down to the coral. At 15:41, the female rose upwards, was joined by the male, and the two swam a short zig-zag pattern parallel to one another. This pattern was immediately followed by a sharp vertical rise of about 15–20 cm, and then by a short burst of level parallel swimming. Quickly thereafter, the pair tilted upwards at a 45–50 deg angle and rapidly ascended less than a meter into the water column. Spawning was accomplished during a sharp turn downward. Afterwards, the pair quickly

made their way down to the edge of the coral thicket. No other individuals were seen in the area and no further courtship activity was detected.

#### *Thalassoma amblycephalum*

Group spawning was observed at Sasanhaya Bay, Rota, Northern Mariana Islands (15 February, 1989), and at Tochelara Ra Ngebard reef passage, northern Palau Islands (29 September, 1992). At Rota, the habitat consisted of a semi-protected reef, dominated by rich growths of *Porites rus* corals in terraces below 10 m, and gently sloping pavement, interspersed with coral pillars and large boulders, above. The habitat at Palau is described above (see *C. cyanopleura*).

At Rota, approximately 35–40 initial phase (IP) fish moved slowly in the water column, ca. 4–5 m above the substratum (10–12 m deep), the fish within the group changing position rapidly. Occasionally, one or more of the fish began to swim erratically and then gradually rise in the water column. As the rise progressed, the fish accelerated and were joined by several individuals. Acceleration became rapid as the group rose in the water column (1–2 m). Spawning was accomplished by a rapid turn downward. The group then moved on, some members falling back and others moving forward, and the process repeated. I observed four such spawns in succession during the morning between 11:00–11:30 when the tide was ebbing.

At Palau, the patterns of behavior were similar. The group, however, was larger (>60 fish) and seemed to move a greater distance along the reef face, but executed spawns near prominent landmarks. Five spawns were observed between 15:35–15:45 while the tide was flooding, including two in which the group temporarily split in two, spawning separately.

## Discussion

### Sexual dichromatism, mating systems and landmarks

Characteristics of courtship and spawning are summarized in Table 2 (terminology follows Colin and Bell, 1991). Five species were temporarily or permanently sexually dichromatic. Temporary full dichromatism was observed in *Oxycheilinus* (as *Cheilinus*) *unifasciatus*, a harem species (Colin

and Bell, 1991). Full permanent dichromatism was observed in *Epibulus insidiator*, *Cirrhilabrus cyanopleura*, and *C. katherinae*, although males of the latter two species enhanced this dichromatism by "turning on" iridescent colors during courtship. This behavior has also been seen in *C. temmincki* (Moyer and Shepard, 1975). *C. cyanopleura* and *C. katherinae* appeared to have a promiscuous mating system similar to that of *C. balteatus* (= *Cirrhilabrus* sp.) reported in Colin and Bell (1991), although Myers (1989) considered *C. cyanopleura* to have a harem mating system. *Thalassoma amblycephalum* also has full permanent dichromatism between female and terminal phase (TP) males that spawn in pairs (Colin and Bell, 1991) but only initial phase (IP) males, which resemble females, and females participated in group spawning in the present study. The mating system may be promiscuous for IP group spawners, and lek-like for TP males (Colin and Bell, 1991). Lek-like mating in other labrids, e.g., *Pteragogus flagellifera* and *Halichoeres melanochir* occur if sex ratios are highly skewed towards females (Moyer and Yogo, 1982; Moyer, 1991). Systems operating in both *C. cyanopleura* and *T. amblycephalum* are probably dependent upon population density, as seen elsewhere in the family, e.g., *Pteragogus flagellifera* (Moyer, 1991). In *T. amblycephalum*, promiscuous group spawning may occur if densities of females and males are high and paired spawning if densities are low (e.g., Colin and Bell, 1991). In *C. cyanopleura*, mating may be promiscuous at high densities (this paper) and harem at low densities (e.g.,

Myers, 1989).

No sexual dichromatism was observed in *Choerodon fasciatus*, *Cheilinus fasciatus*, *C. undulatus*, and *Pteragogus cryptus*. Although the only *Choerodon fasciatus* observed were constantly paired, and only a single pair of *P. cryptus* was observed as well, they seem to be facultatively monogamous (Kleimann, 1977; Wickler and Seibt, 1983; Donaldson, 1989). In this system, individuals maintain essentially monogamous relationships under low population densities. Both species likely have male-dominated harem or lek-like systems consistent with those congeners examined by Colin and Bell (1991) or Moyer (1991).

*Choerodon fasciatus*, *Cheilinus fasciatus*, *E. insidiator*, and *P. cryptus* courted to some degree at specific landmarks. *O. unifasciatus*, a harem species (Colin and Bell, 1991), maintained a territory, and courtship and spawning occurred at a point in the water-column above it which appeared to be a rendezvous site. Although not seen in IP males in this study, TP males of *T. amblycephalum* use landmarks as well (Colin and Bell, 1991). Landmarks function as rendezvous sites in many labrids and the reasons for using them may vary (e.g., Colin and Bell, 1991; Moyer, 1991; Shibuno et al., 1993). Perhaps of primary importance is the value of the site for the fertilization and dispersal of pelagic gametes.

Species that did not appear to utilize readily apparent landmarks, e.g., *C. cyanopleura*, *C. katherinae*, and IP *T. amblycephalum* at Rota, may select courtship areas because of tidal currents at the time of courtship. Current patterns present at courtship sites

**Table 2.** Summary of major patterns of behavior in the courtship and spawning of nine species of wrasses (Labridae)

Pattern	Species								
	CF	CU	CHF	CLC	CLK	EI	OU	PC	TA
Sexual dichromatism	no	no	no	P	P	P	T	no	P**
Mating system	HMG	HMG?	FM	PR*	PR	LL?	HMG	FM	PR/LL**
Patrolling	yes	no	no	yes	yes	yes**	yes	no	no
Parading	no	yes	no	no	no	no	no	no	no
Rendezvous site	yes	?	yes	no	no	yes	yes	yes	yes**
Sway/Zig-zag swim	yes	no	no	no	no	no	no	yes	no
Spawning mode	PA	?	PA	PA	PA	?	PA**	PA	G/PA**
Spawning pre-ascent	GR	?	GR	F	F	?	GR	GR	F

Species codes are: CF, *Cheilinus fasciatus*; CU, *C. undulatus*; CHF, *Choerodon fasciatus*; CLC, *Cirrhilabrus cyanopleura*; CLK, *C. katherinae*; EI, *Epibulus insidiator*; OU, *Oxycheilinus unifasciatus*; PC, *Pteragogus cryptus*; TA, *Thalassoma amblycephalum*. Sexual dimorphism, mating system and behavior codes are: P, permanent; T, temporary; FM, facultative monogamy; HMG, harem mating group; LL, lek-like; PR, promiscuous; PA, pair spawn; G, group spawn; F, fast rise; GR, gentle rise. (\*Myers, 1989; \*\*Colin and Bell, 1991).

could affect fertilization rates, and hence, mating system (Peterson et al., 1992).

In summary, the wrasses described here display considerable diversity in reproductive behavior (Table 2). Sexual dichromism occurs in five species; it is permanent in four species with promiscuous or lek-like mating systems and temporary in one with a harem mating system. Sexual dichromism is absent from two species with confirmed harem mating systems and two which are facultatively monogamous. Harem mating systems occurred in two closely related genera, *Cheilinus* and *Oxycheilinus*. Two genera, *Choerodon* and *Pteragogus*, were facultatively monogamous; the latter genus also has a lek-like mating system if population densities are higher (Moyer, 1991). A lek-like mating system is suspected of TP males of *Thalassoma amblycephalum* (Colin and Bell, 1991) but a promiscuous system operates in IP males of this species. *Epibulus insidiator* may also have a lek-like mating system. Patrolling was observed in five species and four genera, while parading was limited to a single large-sized species, *Cheilinus fasciatus*. Landmarks as rendezvous sites are used in seven species described here with harem, facultatively monogamous, or lek-like mating systems, but apparently not in two species with a promiscuous mating system. Sway or zig-zag swimming during courtship occurs in only two species in two genera. Spawning is paired in seven species, but group spawning also occurs in one of those, *T. amblycephalum*. The spawning pre-ascendant has a gentle rise in species with harem or facultatively monogamous systems, but is fast in species with a promiscuous system.

### Phylogeny and evolution

The use of behavior patterns in resolving phylogenetic relationships between species (e.g., Brooks and McLennan, 1991; Johnston, 1994; Walters, 1994) is increasing in importance, as is the use of phylogenetic methods to trace the evolution of behaviors in related taxa (Brooks and McLennan, 1991). Unfortunately, data bases for a number of taxa are poor. A few behavioral patterns of wrasses described here include shared and unshared characters which should be useful in subsequent analyses between taxa respective of their mating systems.

Patrolling in males, including the use of pronounced fin displays, was observed in *Cheilinus fasciatus*, *O. unifasciatus* and *E. insidiator*. Similar

behavior in these species has been reported from Enewetak (Colin and Bell, 1991) and for *Choerodon azurio* at Miyake-jima (J. T. Moyer, pers. comm.). Parading by *Cheilinus undulatus*, not reported from other species, might have four functional outcomes: attraction of females just prior to courtship around sunset, site selection, assessment of physical conditions leading up to the time of courtship, and courtship synchronization. The first outcome, attraction of females, may be most important for a large-sized wide-ranging species with apparently large home ranges (pers. obs.). Similar outcomes may be expected from patrolling in pairs, as seen in *Choerodon fasciatus*, or *C. azurio*, although patrolling may serve other functions, e.g., territoriality or foraging (J. T. Moyer, pers. comm.).

Swaying and zig-zag swimming occurred in *P. cryptus*. Similar behavior has been reported for a congener, *P. flagellifera* (Moyer, 1991), and may be common in this genus. Zig-zag swimming was also seen in *Cheilinus fasciatus*.

Female *Cheilinus fasciatus*, *Choerodon fasciatus*, *O. unifasciatus*, and *P. cryptus* all employed a gentle rise in the water column as the male approached. The slowness of this rise to join the male in the water column may function as predation risk assessment prior to spawning, e.g., in *P. flagellifera* (Moyer, 1991). Alternately, this pattern may function to synchronize courtship efforts prior to making a rapid spawning ascent. Synchronization may ensure that members of the pair are close to one another so as to maximize fertilization effort (Thresher, 1984; Petersen et al., 1992). In contrast, both promiscuous pair spawning and group spawning species utilized rapid swimming bursts prior to making spawning ascents. Such patterns may also permit synchronization, and facilitate multiple matings by males. Further study of both pre-ascendant patterns, relative to phylogeny and mating system, is needed to trace the evolution of these behaviors within this family.

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西部太平洋のベラ科魚類 9 種の求愛・産卵行動

Terry J. Donaldson

西部太平洋に生息するベラ科魚類である、ヤシベラ、シチセ



## Labrid Reproductive Behavior

ンベラ, クロヘリイトヒキベラ, *Cirrhilabrus katherinae*, *Oxycheilinus unifasciatus*, *Pteragogus cryptus*, およびコガシラベラの求愛・産卵行動を記載した。コガシラベラではグループ産卵が, のこりの6種ではペア産卵が観察された。配偶システムは, ハレムのグループ, 乱婚, グループ産卵につながるレック的行動, あるいは偶発的単婚であった。さらに求愛行動らしいものとして, メガネモチノウオでは1尾の雄と数尾の雌によるバレード行動が, ギチベラでは雄によるパトロール行動が観察された。ここで確

認された異なる行動パターンは, 将来, ベラ科魚類の系統関係を分析し, その行動の進化経路を確かめる際に有用であると思われる。

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