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Comportements reproducteurs du labre oiseau *Gomphosus caeruleus* dans un récif de l'île de la Réunion : mode de reproduction, facteurs environnementaux et alternance des stratégies reproductrices

Reproductive behavior of the green birdmouth wrasse Gomphosus caeruleus *on a Reunion Island reef: Mode of reproduction, environmental factors and reproductive strategy alternation*

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RÉSUMÉ

Le labre-oiseau *Gomphosus caeruleus* est présent toute l'année sur les récifs coralliens de l'île de la Réunion (océan Indien). Un groupe d'individus a été suivi *in situ* dans l'un de ces récifs, avec pour objectif d'étudier le mode de reproduction de l'espèce, l'influence de facteurs environnementaux sur la reproduction, et le rôle des comportements sociaux sur le contrôle de la reproduction. Nos observations permettent de conclure que *G. caeruleus*, comme d'autres Labridae, est une espèce hermaphrodite protogyne et probablement diandrique, que la reproduction de *G. caeruleus*, comme celle d'autres espèces récifales, est influencée par le cycle lunaireavec un pic d'activité reproductrice en phase de lune gibbeuse croissante, et que *G. caeruleus* développe des comportements sociaux conduisant à l'alternance d'une stratégie harémique sur un unique territoire avec une stratégie de type *lek-like* sans agressivité entre mâles. Ces résultats enrichissent la connaissance de la reproduction des Labridae et des espèces récifales.

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A B S T R A C T

The green birdmouth wrasse *Gomphosus caeruleus* is present all year round on the coral reefs of Reunion Island (Indian Ocean). A group of individuals was followed on one of these reefs with the objective of studying the reproduction mode of the species, the influence of environmental factors, and social behaviors on the control of reproduction. Our observations revealed that *G. caeruleus* is, like many Labridae, a protogynous hermaphrodite species, probably diandric, that the reproduction of *G. caeruleus* is, like in other reef fish species, influenced by the lunar cycle with a peak of reproductive activity during waxing gibbous phase, and that *G. caeruleus* displays social behavior leading to alternating haremic mating system on a single territory and *lek-like* mating systems without aggressions between males. These observations enhanced our knowledge of the reproduction of Labridae and reef species.

Abridged version

The green birdmouth wrasse *Gomphosus caeruleus* is present all year round on the coral reefs of Reunion Island in the Indian Ocean (Fig. 1A–B). A group of *G. caeruleus* individuals was followed on one of these reefs to study the reproductive mode and mating system of this species, and determine the influence of social behaviors and environmental factors on reproduction. Observations were performed by snorkeling over 13 months. No fish were captured because the study was performed within the boundaries of the Reunion Island marine protected area (Fig. 1B). Water turbidity was usually quite high, often preventing clear observation of egg release and of rapid reproductive events, lasting no more than a few seconds. Thus, we analyzed reproduction using spawning rushes as proxy. These we define as a quick rush to the surface of a male accompanied by one or multiple females, but not necessarily leading to the expulsion of gametes (Fig. 2D–F, Video S1). During this study, males, by their constant movements within the site, defined three territories (Fig. 1C–F) that differed in size, coral assemblages, and reproductive success–the smallest territory (T1, Fig. 1C–D) was the most successful in terms of females and spawning rush numbers.

Our observations revealed that *G. caeruleus* is similar to many Labridae in exhibiting protogynous hermaphroditism and probably diandry (Fig. 2). This is similar to its sister species *Gomphosus varius*. Females were between 6 and 15 cm long, and were recognizable by a rounded caudal fin lobe, a tubiform snout with a brown to red line on the upper side, and a white neck (Fig. 2 C). Males were always larger than females, from 15 to 20 cm long, they were uniformly dark blue to teal, even on the tubiform snout, and the caudal fin was lunate with thin filaments extending posteriorly at the dorsal and ventral edges (Fig. 2F). Several juveniles smaller than 3 cm were observed on site, and displayed a brown to red–brown color anteriorly and lime green posteriorly, with a white neck similar to that of females (Fig. 2A). Multiple observations included individuals presenting morphological characteristics in size, shape, and colors, intermediate between the juveniles and mature females (Fig. 2B), and between mature females and males (Fig. 2D–E). This supports the hypothesis of protogynous hermaphroditism. Protogynous hermaphroditism of *G. caeruleus* should be validated by histological examination of the gonads of intermediate individuals.

By analyzing the number of males and females present on site, and their territory, social behavior, and courtship (Fig. S2, Video S1), we could demonstrate that the group mating system is dominated by a haremic organization on a single-territory, alternating with short periods of *lek-like* mating without aggressiveness between males. This is atypical for a *lek-like* mating system in fish. Few aggressive behavior events were however observed from males toward females, which could actually be primary males. We noticed that females chose the site of reproduction by positioning themselves on specific corals (Fig. 3A, Fig. S2C). Females were also the drivers of the transition from the haremic to the *lek-like* mating system. Males chose when to reproduce, which females to reproduce with, and likely initiated the transition from the *lek-like* to the haremic mating system. Short periods of *lek-like* mating were associated with variations in population density (linked with an increased number of females fitting a "hotspot" model) and/or seasonal changes between the winter solstice and the spring equinox. Seasonality of switching between reproductive systems should be confirmed over several years.

Reproductive events followed a daily cycle and occurred exclusively from mid-morning to early afternoon. Statistical analyses of the number of spawning rushes observed per day revealed that the reproduction of *G. caeruleus* is similar to that of other reef fish species in being influenced by the lunar cycle with peak of reproductive activity before the full moon. Both the number of females present on site and the observed number of spawning rushes were significantly higher during the waxing gibbous phase compared to other lunar phases (Fig. 4A–B). The number of observed spawning rushes was positively and linearly correlated with the number of females present on site (Fig. 4C), but the average number of spawning rushes per female remained higher during waxing gibbous lunar phases (Fig. 4D). The moon cycle could provide a temporal reference for reproductive aggregates, stimulate oogenesis, and/or maximize larval recruitment, similarly to other fish species. Histological study of ovaries and study of larval recruitment are required to test these hypotheses.

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