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PIGMENTATION VARIATION IN THE ANEMONEFISH *AMPHIPRION OCELLARIS* (TELEOSTEI: POMACENTRIDAE): TYPE, STABILITY AND ITS USEFULNESS FOR INDIVIDUAL IDENTIFICATION

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ABSTRACT. - Variation in pigment pattern between *Amphiprion ocellaris* individuals was examined from photographs to identify individual morphological variation. Variation was observed in the shape of the three vertical white bars on the fish. Photographs taken after eight months indicated that bar shape appeared stable. Fin outer margin pigmentation was not found to be stable over the study period. Individuals over 40 mm in total length could be readily distinguished over the eight-month study period. Identification was less obvious in fish under 40 mm, due to the smaller size of photographic images and the developing caudal bars of recently recruited individuals.

INTRODUCTION

Genetically determined patterns of pigmentation are very stable (Pennycuick, 1978) although pigment modification associated with change in sex and social rank was observed in *Amphiprion clarkii* (see Moyer, 1976). Individual identification using natural markings is an essential procedure when considering social behaviour (Pennycuick & Rudnai, 1970), individual fecundity (Foster, 1966), and estimates of abundance, survival rates and rates of population increase (Hammond, 1990). Aldenhoven (1986) based individual identification of the coral reef fish *Centropyge bicolor* on differences in size and colour markings, especially bar pattern posterior to the pelvic fin and the shape of the line dividing the blue and yellow body colours.

The coral reef anemonefish *A. ocellaris* is typically bright orange with three lateral vertical white bars, the middle one with an anteriorly protruding bulge. These bars occasionally have narrow black margins. Fin outer margins are also often darkly pigmented. Total length ranges up to 110 mm. In the present study we consider pigmentation pattern variation and stability amongst individuals of *A. ocellaris*. The usefulness of the variation for individual identification using natural markings is discussed.

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MATERIALS AND METHOD

One hundred and ten specimens of *A. ocellaris* were first photographed in March 1993 at three sites on the patch reef Terumbu Pemalung Besar and two fringing reefs off Kusu Island and Raffles Lighthouse, which are all located in Singapore's Southern Islands range. A second photographic survey, including 122 fish was conducted in November 1993. Individual fish were removed from their host anemone with a hand net and placed in A4-size plastic bags. A fixed distance Nikonos 80 mm close-up lens was used to photograph their right lateral view. A ruler was attached to the field frame which allowed total length data to be collected. Capture and photography of an individual usually took less than 2 minutes.

RESULTS AND DISCUSSION

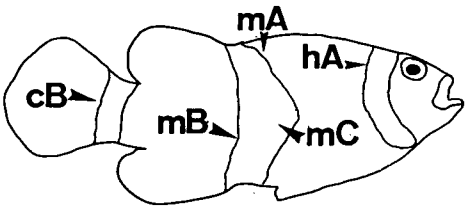
Pigment pattern variation between individuals. - The three vertical white bars all displayed variation between individuals (fig. 1). Individually distinguishing characteristics included bar width (especially in middle bar), dorsal to ventral change in bar width, bar profile shape ranging from concave to straight to convex (except in the head bar), bar pigment protrusions and intrusions, jagged bar edges (especially in the head bar) and anterior head bar protrusion towards the eye. More obvious macro-variation included incomplete caudal bar development. Bar pigmentation variation was less obvious and appeared less stable in juveniles due to the limits of photographic resolution and developing caudal bar pigmentation.

All individuals had black pelvic fin outer margins. Blackening of the other fin outer margins was more variable, ranging from complete to no darkening of fin outer margins. There was no apparent correlation between length of individuals and the extent of fin pigmentation.

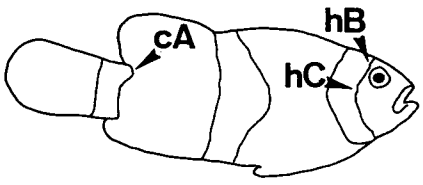
Pigment pattern stability. - All 79 individuals positively re-identified after eight months showed no change in pigmentation in any of the bars. Also if one bar matched then all bars matched. The exception was for the more homogenous caudal bar which was indistinguishable in several individuals. We matched the two sets of photographs without reference to on which reefs photographs had been taken. As obligate symbionts with sea anemones, immigration between reefs is unlikely, suggesting that if photographs were matched from different reefs then they had probably been mistakenly matched. None of the March and November photographs matched were from different reefs.

Matched March and November photographs based on the variation in the shape of the three vertical white bars suggested that the outer margin pigmentation of the fins was not stable. Intensity of darkened fin outer margins, with the exception of the pelvic fin, changed by either fading or becoming more intense.

Pigmentation variation as a criteria for individual identification. - We were able to match photographs of individuals with confidence. Confidence in accurate identification also increased with the total length of individuals. In cases where bar shapes were similar, profile protrusions (Fig.1.1. hD, mA, cA; 1.3. mC, cA, cC; 1.5. c.C), intrusions (1.1. mB, hB, hC; 1.3. hB, hC; 1.5. mB, cA, cB), jagged edges (1.1. hA, cB; 1.3. cB) and the extent of the protrusion towards the eye (1.3. hA; 1.5. hC) were particularly important for distinguishing individuals. Fin outer margin pigmentation which appeared temporally unstable, should be excluded as an identifying characteristic.

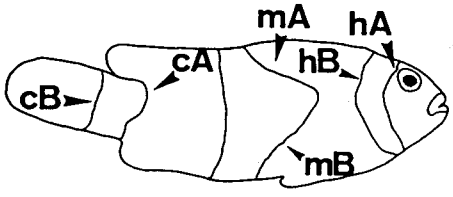


1.1



1.2

h - hA-smoother upper posterior edge, hB-no protrusion towards eye, hC-no anterior protrusion
m - mA-larger upper anterior protrusion, mB-lower posterior intrusion, mC-wider bar
c - cA-no massive upper anterior protrusion, cB-jagged posterior edge



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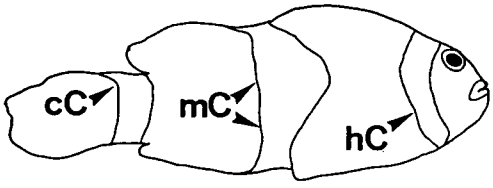
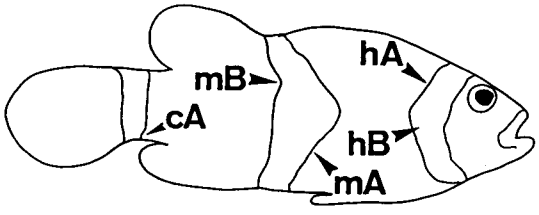
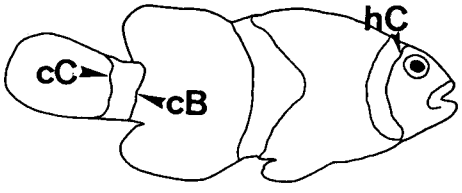


1.4

h - hA-large protrusion towards eye, hB-upper posterior intrusion, hC-no lower posterior intrusion
m - mA-concave upper anterior profile, mB-jagged lower anterior profile, mC-no posterior protrusions
c - cA-massive upper anterior protrusion, cB-jagged posterior edge, cC-no upper posterior protrusion



1.5



1.6

h - hA-straighter lower anterior profile, mB-upper posterior intrusion
m - hA-smoother posterior edge, hB-wider bar, hC-no protrusion towards eye
c - cA-lower anterior intrusion, cB-no middle anterior intrusion, cC-no upper posterior protrusion

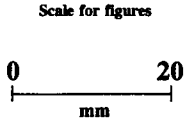


Fig. 1. Differentiation of quite similar *Amphiprion ocellaris* individuals based on bar pigment variation. Distinguishing characteristics include: Head bar (h) possession of protrusion towards eye, bar protrusions and intrusions, jagged edges and width of bar; Middle bar (m) possession of concave, convex or straight bar profile, bar protrusions and intrusions and jagged edges; Caudal bar (c) possession of bar protrusions and intrusions and jagged edges.

Given the caudal bar pigment development of recently recruited individuals and the conspicuousness of variation in smaller fish it is suggested that ecological studies of *A. ocellaris* based on this method be confined to individuals over 40 mm, or include regular photographing of fish so caudal bar development can be followed. Consideration of both lateral views of an individual were not considered in this study although it is our experience that they are not symmetrical. Such an approach would require more analytical persistence but may be necessary if very large numbers of individuals were under consideration.

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