*Marine and Freshwater Research* 2016, **67**, 75–83
http://dx.doi.org/10.1071/MF14208_AC 

**Supplementary material**

# Feeding habits of range-shifting herbivores: tropical surgeonfishes in a temperate environment

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*Marine and Freshwater Research* 2016, **67**, 75–83
http://dx.doi.org/10.1071/MF14208_AC


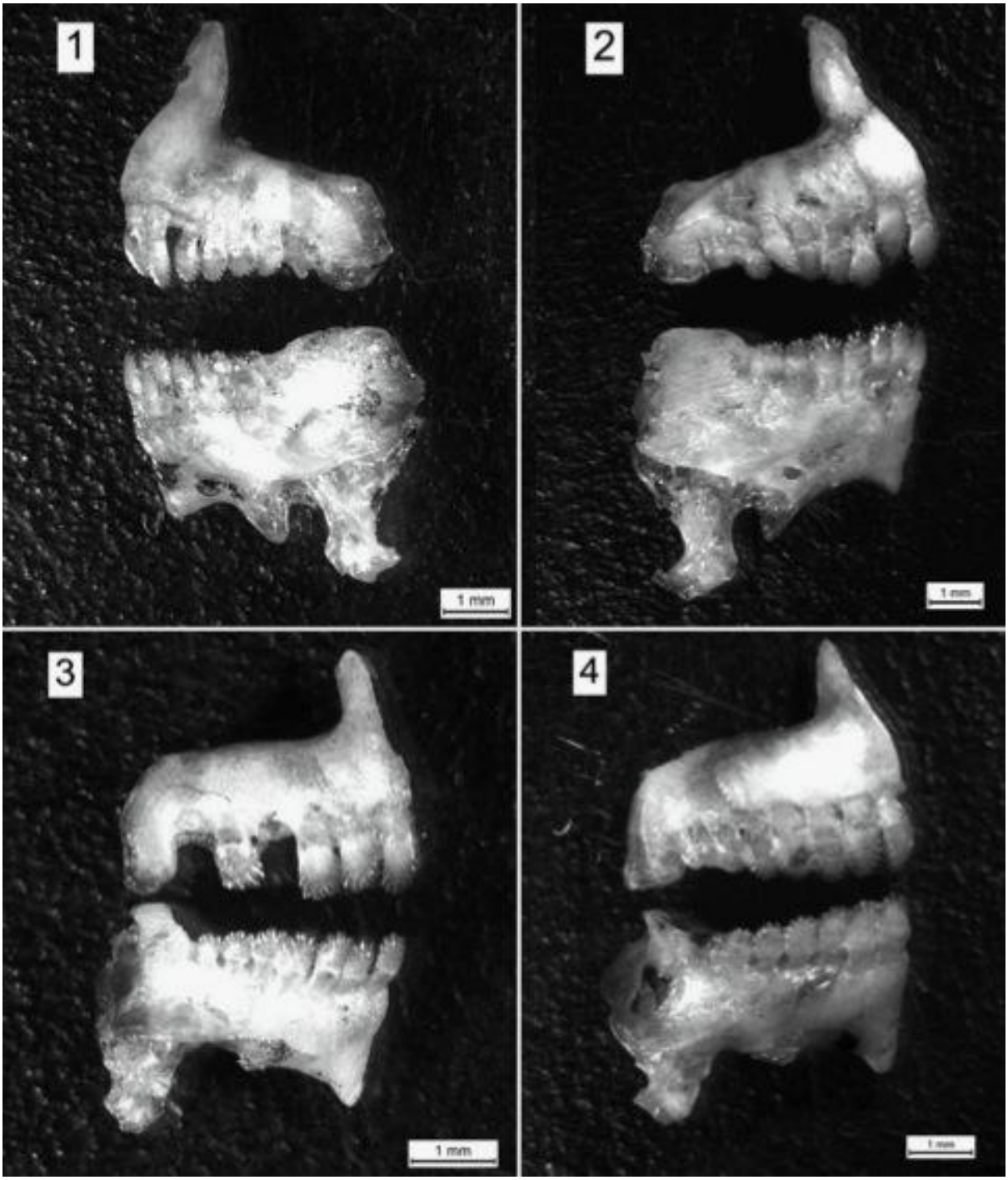


**Fig. S1.** Stereoscopic microscope images of the morphology of the jaw apparatus of (1) *Prionurus maculatus*, (2) *Prionurus microlepidotus*, (3) *Acanthurus triostegus* and (4) *Acanthurus dussumieri*. Scale bar: 1 mm.

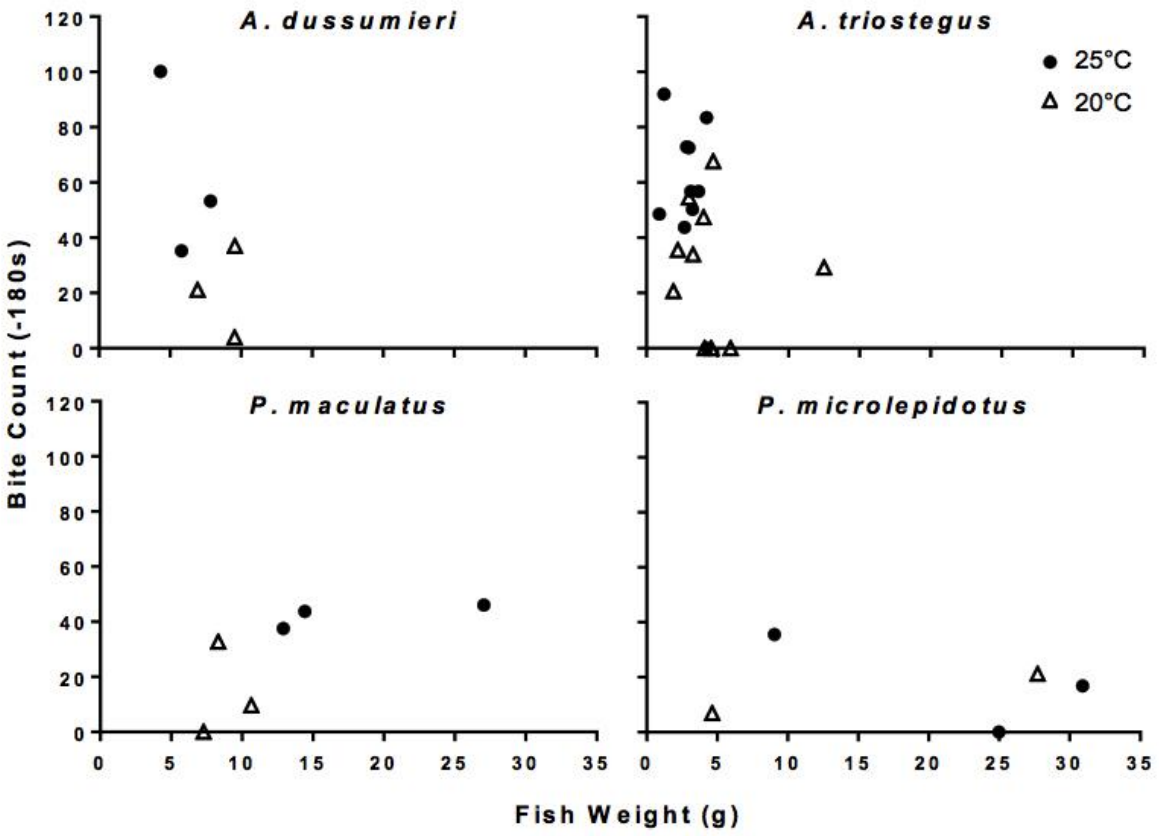


**Fig. S2.** Aquaria trial bite rates across individual sizes (g) of tropical (*A. dussumieri*, *A. triostegus*) and warm-temperate (*P. maculatus*, *P. microlepidotus*) surgeonfishes in tropical (25°C) and temperate (20°C) water temperatures.

**Table S1. Number of field surveys performed at each Sydney site from February to July 2013**

| Site | February | March | April | May | July | Total |
|---|---|---|---|---|---|---|
| Clovelly | 1 | 2 | 2 | 1 | | 6 |
| Gordon's Bay | 1 | | | | | 1 |
| La Perouse | | 1 | 1 | | 1 | 3 |
| Little Bay | 1 | 3 | 2 | | | 6 |
| Long Bay | 1 | | | | | 1 |
| Shelly Beach | | 3 | 1 | 1 | 2 | 7 |
| Total | 4 | 9 | 6 | 2 | 3 | 24 |

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**Table S2. Analysis of field bite rates of tropical and warm-temperate surgeonfishes**

Origin was fixed with two levels (Tropical, Warm-Temperate), Species was randomly nested in Origin, with two levels, Schooling was fixed with three levels (single-species, mixed, solitary) ($n$ = 2–14). Temperature was fitted as a covariate. $P$-values were calculated using 9999 permutations under a reduced model. Pairwise tests for Schooling: Single species > Mixed Species = Solitary

| Source | d.f. | m.s. | Pseudo-$F$ | $P$ |
|---|---|---|---|---|
| Temperature | 1 | 347 | 0.55 | 0.45 |
| Origin | 1 | 231 | 0.32 | 0.59 |
| Schooling | 2 | 3303 | 30.69 | <0.01 |
| Species(Origin) | 2 | 724 | 1.15 | 0.33 |
| Temperature × Origin | 1 | 19 | 0.03 | 0.86 |
| Temperature × Schooling | 2 | 512 | 0.87 | 0.42 |
| Origin × Schooling | 2 | 97 | 1.73 | 0.35 |
| Temperature × Species(Origin) | 2 | 1394 | 2.21 | 0.12 |
| Species(Origin) × Schooling | 3 | 45 | 0.07 | 0.97 |
| Temperature × Origin × Schooling | 2 | 382 | 0.61 | 0.49 |
| Temperature × Species(Origin) × Schooling | 2 | 678 | 1.08 | 0.31 |
| Residual | 55 | 631 | | |

**Table S3. Analyses of total algal biomass consumption, bite rates and consumption of brown algal biomass by tropical and warm-temperate surgeonfishes in aquarium trials**

Data were log-transformed to improve test assumptions. Temperature was fixed with two levels (25 and 20°C), Origin was fixed with two levels (Tropical, Warm-Temperate) and Species was randomly nested in Origin, with two levels ($n$ = 2–10). $P$-values were calculated using 9999 permutations under a reduced model. Non-significant terms with $P > 0.25$ were pooled to increase the power of the main effects of interest (temperature and origin; as per Underwood 1997). For brown algal consumption, pairwise tests for Temperature × Species(Origin): within level *Acanthurus dussumieri*; 25°C > 20°C

| Aquarium trial | Source | d.f. | m.s. | Pseudo-$F$ | $P$ |
|---|---|---|---|---|---|
| Total algal consumption | Temperature | 1 | 4.68E-03 | 1.10 | 0.32 |
| | Origin | 1 | 5.06E-02 | 12.77 | < 0.01 |
| | Species(Origin) | 2 | 1.05E-02 | Pooled | |
| | Temperature × Origin | 1 | 1.36E-02 | 2.75 | 0.11 |
| | Temperature × Species(Origin) | 2 | 5.56E-04 | Pooled | |
| | Residual | 29 | 6.78E-03 | | |
| Aquaria bite rates | Temperature | 1 | 4460.1 | 8.82 | < 0.01 |
| | Origin | 1 | 2843.4 | 6.77 | 0.02 |
| | Species(Origin) | 2 | 214.3 | Pooled | |
| | Temperature × Origin | 1 | 652.82 | 1.00 | 0.32 |
| | Temperature × Species(Origin) | 2 | 310.66 | Pooled | |
| | Residual | 29 | 524.98 | | |
| Brown algal consumption | Temperature | 1 | 1.42 | 0.70 | 0.50 |
| | Origin | 1 | 0.48 | 0.94 | 0.66 |
| | Species(Origin) | 2 | 0.51 | 0.95 | 0.41 |
| | Temperature × Origin | 1 | 0.34 | 0.17 | 0.72 |
| | Temperature × Species(Origin) | 2 | 2.07 | 3.87 | 0.04 |
| | Residual | 18 | 0.53 | | |

**Table S4. Linear regression analyses of bite rates *v.* fish weight (g) for (a) each Species (*n* = 5–20) and (b) for each combination of Origin (Tropical, Warm-Temperate) × Temperature (25 and 20°C) (*n* = 5–13)**

| | Factor | Residual d.f. | Coefficient | s.e. of coefficient | *P* |
|---|---|---|---|---|---|
| Species | *A. dussumieri* | 4 | –11.39 | 5.57 | 0.11 |
| | *A. triostegus* | 18 | –3.67 | 2.67 | 0.19 |
| | *P. maculatus* | 4 | 1.77 | 0.98 | 0.15 |
| | *P. microlepidotus* | 3 | –0.18 | 0.66 | 0.80 |
| Origin × Temperature | Tropical *v.* 25°C | 11 | –3.04 | 4.27 | 0.49 |
| | Tropical *v.* 20°C | 11 | –1.17 | 2.03 | 0.58 |
| | Warm-Temperate *v.* 25°C | 4 | –0.94 | 0.89 | 0.36 |
| | Warm-Temperate *v.* 20°C | 3 | 0.50 | 0.76 | 0.56 |

**Table S5. Analyses of relative gut index, opening jaw-lever ratio and closing jaw-lever ratio of tropical and warm-temperate surgeonfishes**

Origin was fixed with two levels (Tropical, Warm-Temperate) and Species was randomly nested in Origin, with two levels (*n* = 3–5). *P*-values were calculated using 9999 permutations under a reduced model. Monte Carlo ($_{MC}$) *P*-value was used where there were <99 unique permutations

| Morphological analysis | Source | d.f. | m.s. | Pseudo-*F* | *P* |
|---|---|---|---|---|---|
| Relative gut indices | Origin | 1 | 1.98 | 2.65 | $_{MC}$0.25 |
| | Species(Origin) | 2 | 0.75 | 6.97 | < 0.01 |
| | Residual | 16 | 0.11 | | |
| Opening lever ratio | Origin | 1 | 6.11E-04 | 0.61 | $_{MC}$0.52 |
| | Species(Origin) | 2 | 1.01E-03 | 4.59 | < 0.05 |
| | Residual | 16 | 2.21E-04 | | |
| Closing lever ratio | Origin | 1 | 1.41E-03 | 0.08 | $_{MC}$0.80 |
| | Species(Origin) | 2 | 1.81E-02 | 3.77 | 0.06 |
| | Residual | 16 | 4.79E-03 | | |

## Reference

Underwood, A. J. (1997). ‘Experiments in Ecology: their Logical Design and Interpretation using Analysis of Variance.’ (Cambridge University Press: Cambridge, UK.)