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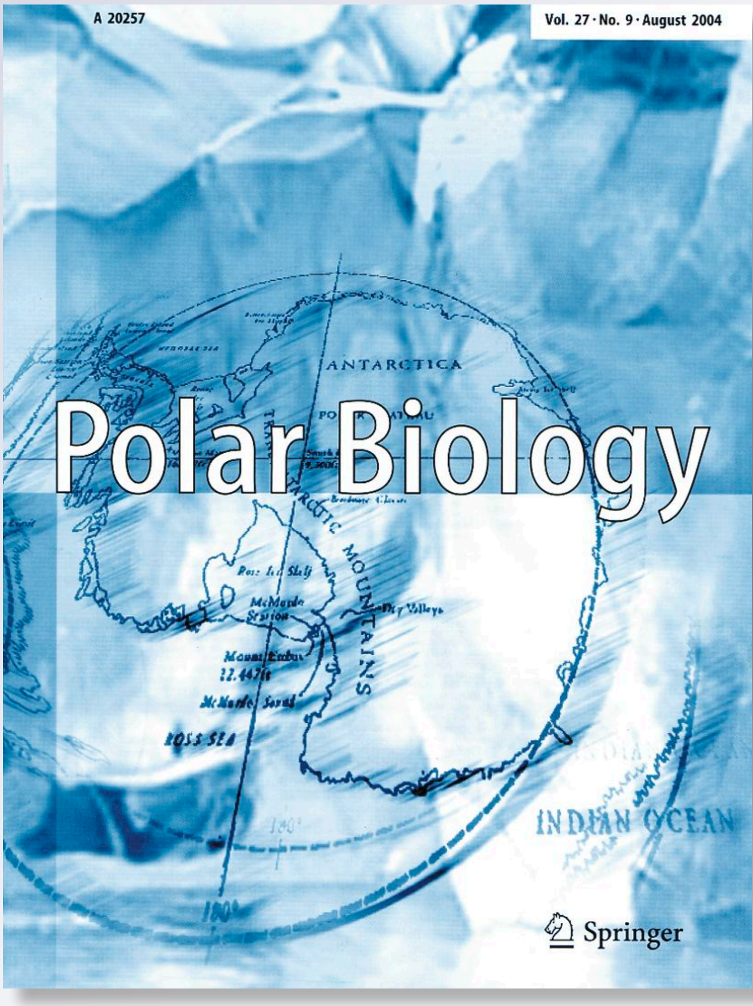

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ORIGINAL PAPER

Phenotypic plasticity in the Antarctic nototheniid fish *Trematomus newnesi*: a guide to the identification of typical, large mouth and intermediate morphs

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Abstract *Trematomus newnesi* is a common inshore species with a circum-Antarctic distribution. It provides the only known example of phenotypic plasticity in Antarctic notothenioid fish, existing as populations of typical, large mouth and intermediate morphs that can be difficult to identify. Using specimens from both Potter Cove, King George/25 de Mayo Island, and from McMurdo Sound, we found that the morphometric measurements gape width/head length (HL), upper jaw length/HL and, to a lesser extent, orbit diameter/HL reliably separated the morphs. For use in a key, we converted the ratios into the qualitative characters head shape, head width and upper jaw length relative to middle of the eye. To increase the reliability of the key, we also assessed intra-morph variability in these characters. The key is supplemented with colour photographs illustrating the distinctive features for separation of the morphs. We discovered that, in the case of the specimens from Potter Cove, each morph had a distinct pattern of colouration: typical—trunk blotched, with yellow or orange-brown predominating especially on pectoral and caudal fins; large mouth—trunk blotched, with green predominating especially in pectoral and opercular regions; and intermediate—trunk less blotched, with homogeneous dark brown-grey on trunk, pectoral and caudal fins. We also discuss the ecological implications of colour in the morphs.

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Introduction

The circum-Antarctic notothenioid fish *Trematomus newnesi* Boulenger 1902 is commonly found in shallow inshore waters from 20–25 m deep on rocky bottoms with macroalgae beds (DeWitt et al. 1990; Barrera-Oro 2002). It also may be found farther offshore on the shelf to depths of 450 m (Tiedtke and Kock 1989). Its accessibility and local abundance have made it a frequent subject for both ecological studies (Radtke et al. 1989; Vacchi and La Mesa 1995; La Mesa et al. 2000; Barrera-Oro and Piacentino 2007) and physiological/biochemical/genetic work (D'Avino et al. 1994; Hazel and Sidell 2004; Van Houdt et al. 2006). It is unusual among notothenioids in exhibiting considerable phenotypic plasticity and exists as "typical" and "large mouth" morphs (Eastman and DeVries 1997) as well as a series of "intermediate" morphs (Piacentino and Barrera-Oro 2009). This example of phenotypic plasticity is especially perplexing because it has not yet been linked with divergence in habitat or diet, and thus the ecological significance of the morphism in *T. newnesi* is unclear. For example, Eastman and Barrera-Oro (2010) found that, in spite of the distinct external appearance and possession of a relatively heavier skeleton in the large mouth morph, there were no significant differences in measurements of buoyancy among any of the morphs and therefore no support for the hypothesis that the large mouth morph is less buoyant/more benthic than the typical semipelagic morph.

The identification of the typical and the large mouth morphs of *T. newnesi* may be difficult and is confounded by the presence of intermediate forms. At McMurdo Sound,

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Table 1 Collection data for morphs of *Trematomus newnesi* from the McMurdo Sound area of the Ross Sea and from Potter Cove on King George/25 de Mayo Island

Locality	Date	Gear	Depth (m)	*N*	Standard length (mm)
McMurdo	Oct–Nov 1998	Hook and line	9–14	36	122–183
Potter Cove	Dec 2008–Mar 2009	Bottom trawl and Trammel net	6–40	30	119–186
Potter Cove	Dec 2009–Jan 2010	Bottom trawl and Trammel net	8–40	35	126–185
Potter Cove	Sept–Nov 2010	Trammel net	24–50	27	142–189

Eastman and DeVries (1997) documented differences between the typical morph and the large mouth morph that has a wider and blunter head, longer upper jaw, wider gape and dark uniform colouration. Subsequently, Piacentino and Barrera-Oro (2009) identified these two morphs as well as an intermediate morph at Potter Cove, King George/25 de Mayo Island in the South Shetland Islands and at Petermann Island, western Antarctic Peninsula, and noted that the eye diameter relative to head length was smaller in the large mouth morph.

Because *T. newnesi* can be encountered throughout coastal Antarctica where most stations are located, it would be desirable for researchers to have a dependable and easy means of identifying the morphs. Therefore, using samples from both Potter Cove and McMurdo Sound, our objectives are to: (1) statistically evaluate and identify the most reliable morphometric and qualitative characters for separation of morphs; (2) provide photographs and a key for identification of the morphs; and (3) assess the utility of body colouration for separation of morphs and its possible relationship with habitat.

Materials and methods

The specimens of *T. newnesi* used in this study were collected at Inaccessible Island (77°39′S; 166°21′E), McMurdo Sound, in the southwestern Ross Sea close to the US McMurdo Station in 1998 and at Potter Cove (62°14′S, 58°43′W), King George/25 de Mayo Island, South Shetland Islands, close to the Argentine Scientific Station Jubany in the late 2000s. The characteristics of the sampling and fish processed are shown in Table 1. The abiotic features and biotic components of these sites as well as further details on the fishing equipment and sampling procedures are given in Eastman and DeVries (1997) for McMurdo and in Casaux et al. (1990) for Potter Cove. The first set of samples from Potter Cove was also used in a recent study on buoyancy of *T. newnesi* (Eastman and Barrera-Oro 2010). We recorded total and standard length to the nearest 0.1 cm below, weight in g and the sex of fish.

The morphometric measurements and the statistical analysis for the three morphs of *T. newnesi* were carried out on all the specimens collected at McMurdo Sound and on the specimens from Potter Cove collected in Sept–Nov 2010 (Table 2). Our morphometric measurements followed those in Hubbs and Lagler (2004). All specimens from both sites were used in the analysis of the qualitative characters (Table 3) in the key for morph identification. Eastman and DeVries (1997) and Piacentino and Barrera-Oro (2009) may be consulted for complete data on the morphometric and qualitative characters that distinguish the morphs. These are not repeated here because our goal is to identify and use only the most valid, obvious and easy-to-use characters in the key. We also consider the validity of "colour" as a character and obtained photographs of the *T. newnesi* morphs, using the specimens collected in McMurdo in 1998 and in Potter Cove in spring 2010.

We used the program SPSS 16.0 for statistical analysis of the three morphometric ratios. The Kolmogorov–Smirnov test indicated that 16 of 18 values for morphs from the two localities were normally distributed. Levene's test indicated homogeneity of variances. Because morphometric measurements are ratios, we performed an arcsine transformation to ensure that the variance was independent of the mean. Our null hypotheses were that there were no differences in any measurements among the morphs. We used a one-way ANOVA to test for differences among means for the morphs with Bonferroni post hoc tests to determine which pairs of means differed between morphs and to adjust for multiple comparisons thereby ensuring acceptance of a conservative P value. Data values in the tables and text are untransformed, but reported levels of significance are for arcsine-transformed data.

Results

Identification of morphs using morphometric and qualitative characters

The morphometric measurements used for the identification of morphs are presented in Table 2. The magnitude of the values between McMurdo and Potter Cove specimens were similar for upper jaw length/head length (HL) and orbit diameter/HL but were higher with less overlap for gape

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Table 2 Selected morphometric measurements for three morphs of *Trematomus newnesi* from a sample of 36 specimens (SL = 122–183 mm) collected in McMurdo Sound area and 27 specimens (SL = 142–189 mm) from Potter Cove of King George Island/25 de Mayo Island

Morphs	*N*	Gape width/head length (%) Mean (range) ± SD	Upper jaw length/head length (%) Mean (range) ± SD	Orbit diameter/head length (%) Mean (range) ± SD
McMurdo Sound				
Typical	8	33.3 (30.4–37.9) ±2.4	46.4 (43.5–49.1) ±1.7	26.7 (24.9–28.5) ±1.3
Intermediate	17	36.1 (31.8–39.2) ±2.5	48.5 (43.8–53.2) ±2.8	26.0 (24.0–28.6) ±1.3
Large mouth	11	41.2 (37.4–46.1) ±2.8	51.6 (46.6–55.9) ±2.6	25.1 (22.8–26.6) ±1.3
$F_{2,33}$		23.975	10.150	3.537
P		0.000	0.000	0.041
		T vs. LM***	T vs. LM***	T vs. LM*
		LM vs. I***	LM vs. I**	
Potter Cove				
Typical	10	38.3 (34.3–42.0) ±2.9	45.4 (41.9–52.0) ±2.6	26.4 (25.6–28.3) ±0.9
Intermediate	8	42.0 (38.7–47.2) ±3.2	47.0 (43.5–52.2) ±3.5	25.3 (23.0–27.2) ±1.6
Large mouth	9	46.9 (44.2–49.3) ±2.1	51.6 (44.8–54.6) ±3.3	24.2 (22.7–26.7) ±1.1
$F_{2,24}$		23.065	9.705	8.270
P		0.000	0.001	0.002
		T vs. LM***	T vs. LM**	T vs. LM**
		T vs. I*	LM vs. I*	
		LM vs. I**		

Ratios are for untransformed data expressed as percentages. Results of a one-way ANOVA are in rows four and in the columns beneath are pairs of morphs (denoted by the first letter of the name) that differ significantly, with *P* values derived from Bonferroni post hoc tests on arcsine-transformed data (*** $P \leq 0.000$, ** $P \leq 0.01$, * $P \leq 0.040$)

Table 3 Qualitative characters used in distinguishing and keying out the morphs of *Trematomus newnesi* from the McMurdo Sound area of the Ross Sea and the Potter Cove of King George/25 de Mayo Island

Morphs	*N*	Head shape in dorsal view			Head width at opercles			Position of posterior end of maxilla relative to eye			Colour[a]		
		V	Inter.	U	Narrow	Inter.	Wide	Ant.	Mid.	Post.	1	2	3
McMurdo Sound													
Typical	8	8	0	0	7	1	0	3	5	0			
Intermediate	17	5	11	1	0	17	0	0	8	9			
Large mouth	11	0	0	11	0	1	10	0	2	9			
Potter Cove													
Typical	28	26	2	0	25	3	0	22	6	0	10	0	0
Intermediate	37	10	18	9	4	29	4	3	30	4	0	0	8
Large mouth	27	0	0	27	0	1	26	0	7	20	0	9	0

Intra-morph variability in distribution of characters is also shown

[a] Colour in the fresh condition: 1, mottled with yellow or orange-brown colouration especially on pectorals and caudal; 2, mottled with green colouration especially on pectorals and opercular area; and 3, more homogeneous dark brown-grey colouration. The character "colour" was analysed only on fish collected in PC in spring 2010

width/HL in Potter Cove fish (see "Discussion"). As would be expected, intermediate morphs had intermediate values for all ratios at both localities. The *P* values for the ANOVA indicated that the differences among morphs were significant at both localities. The *P* values for the pair-wise comparisons are proxies for the relative degree of reliability of the characters and suggest that all three ratios separated the typical and large mouth morphs but that gape width was the only ratio that could distinguish typical from intermediate morphs (and only in the Potter Cove specimens). Both gape width and upper jaw length separated large mouth from intermediate morphs. The small inter-morph differences in orbit diameter were not detectable with the naked eye, but were significantly different in the typical and large

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mouth morphs. Thus, gape width and upper jaw length are the most reliable ratios, and the most difficult determination is between the typical and intermediate morphs.

Of the total number of fish ($N = 128$) from McMurdo ($N = 36$) and Potter Cove ($N = 92$) identified by using the four qualitative characters in Table 3, 28.1% were typical morphs, 29.7% large mouth morphs and the remaining 42.2% were intermediate forms (Table 3). We included in the category "intermediate" those fish that showed a variety of transitional morphologies within the specific characters used for the identification of the morphs typical and large mouth. We found a predominance of the intermediate morph in both localities, similar proportions of the typical and large mouth morphs at Potter Cove (≈30%) and a higher proportion of large mouth (30.5%) over typical (22%) morphs at McMurdo. As can be seen in examining Table 3, characters such as the position of the maxilla relative to the eye and head shape are variable and do not necessarily co-occur in intermediate morphs, meaning that some of these morphs may not exhibit intermediate states for both characters. This must be kept in mind in keying out these specimens.

Photography

Photographs of selected individuals of similarly sized typical, large mouth and intermediate morphs illustrate the qualitative diagnostic characters used in separation of the morphs (Figs. 1, 2, 3, 4). A detailed comparison of the diagnostic features between typical and large mouth morphs is presented in Fig. 1 in lateral (a, b), dorsal (c, d), frontal (e, f) and ventral (g, h) views of specimens collected at Potter Cove. Likewise, the character "colour" was primarily examined on living specimens from this site in spring 2010 soon after capture, before placing the fish in aquarium or freezing them. There were clear differences in the colour of the morphs when alive (Fig. 2a–c) versus after death (Fig. 2d–f). The morphs from Potter Cove displayed the following colour patterns (Figs. 2a–c, 3): typical—mottled with yellow or orange-brown colouration especially on pectorals and caudal; large mouth—mottled with green colouration especially in pectorals and opercular area; and intermediate—a more homogeneous dark brown-grey colouration.

Live specimens from McMurdo were drabber and less obviously blotched than those from Potter Cove, but we do not have photos of these. When preserved in formalin, their colour was muted, with primary tones of grey (Fig. 4).

Key to the morphs of *Trematomus newnesi*

Knowing the relative degree of reliability of the morphometric characters, we converted these to qualitative characters for use in the key presented below. For example, the ratio gape width/HL is converted to a simple qualitative assessment of head width at the opercles, and upper jaw length/HL is converted to noting of the position of the posterior end of the maxilla relative to the middle of the eye. Thus, the key is based solely on the easily observable qualitative external morphological characters in Table 3. The distribution of the states of the characters in Table 3 provides insight into the extent of intra-morph variation. The sequence of characters in the couplets proceeds from those with little intra-morph variation to those with more. The large mouth morph is a distinctive morph with the least variable characters and keys out first. Identification of the intermediate morph is complicated by the variability of character states, and they are not necessarily all intermediate. The key should be used in conjunction with the photographs in Figs. 1, 2, 3, and 4.

1a Anterior margin of head U-shaped in dorsal profile; head wide at opercles; maxilla ends posterior to middle of eye (sometimes at middle of eye); trunk blotched, with green colour predominating especially in pectoral and opercular regions… **Large mouth morph**

1b Anterior margin of head V-shaped or intermediate in shape; head narrow or intermediate at opercles; maxilla variable but usually ends at middle of eye (sometimes posterior to middle); trunk blotched, with yellow or orange-brown colour predominating especially on pectoral and caudal fins or body less distinctly blotched with homogeneous dark brown-grey colouration… **2**

2a Anterior margin of head usually V-shaped; head usually narrow at opercles; maxilla ends anterior to middle of eye (sometimes at middle of eye); trunk blotched, with yellow or orange-brown colour predominating especially on pectoral and caudal fins… **Typical morph**

2b Anterior margin of head usually intermediate between U- and V-shape (sometimes V-shaped, occasionally U-shaped); head usually intermediate in width (occasionally narrow or wide); maxilla usually ends at middle of eye (sometimes posterior to middle, occasionally anterior); blotching on trunk less evident, and trunk, pectoral and caudal fins with homogeneous dark brown-grey colouration… **Intermediate morph**

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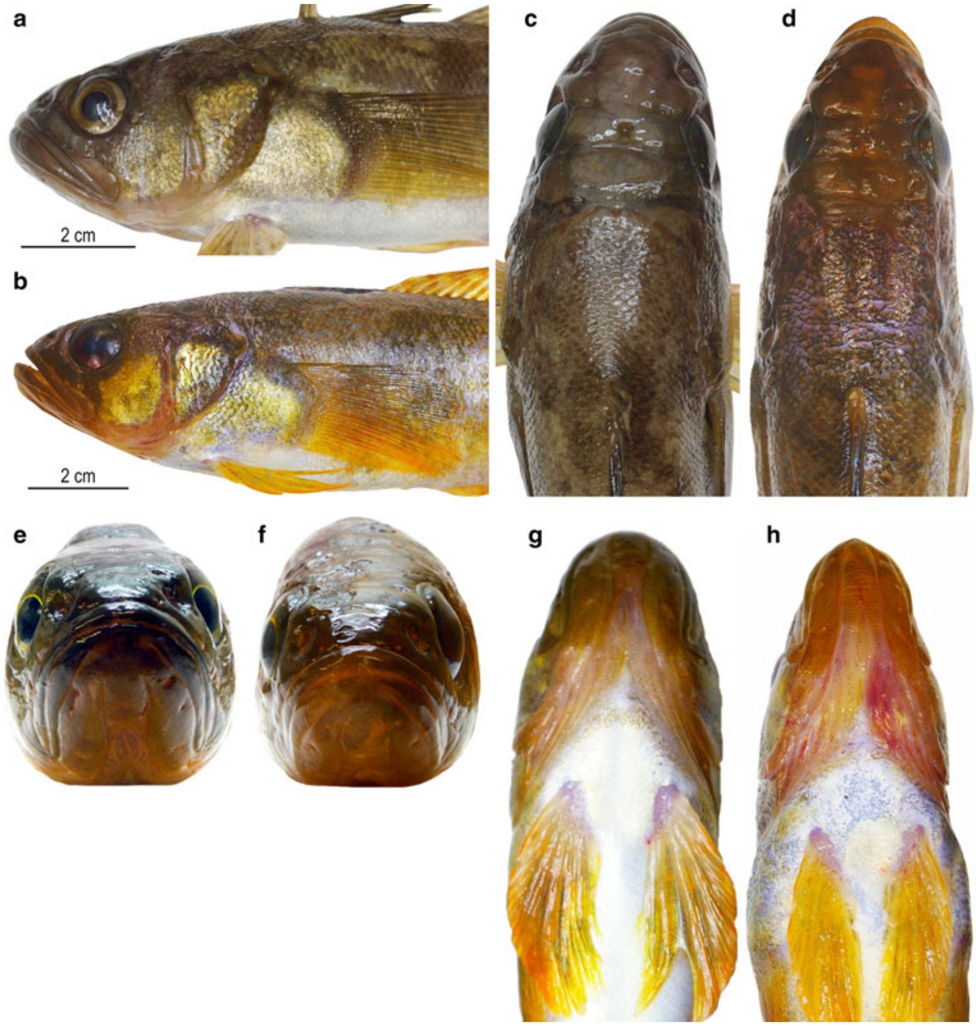

Fig. 1 Diagnostic differences between similarly sized large mouth (**a**, **c**, **e**, **g**) and typical (**b**, **d**, **f**, **h**) morphs of *Trematomus newnesi* from Potter Cove. **a**, **b** *Lateral* views showing size of jaws and position of the posterior end of the maxilla relative to the eye. **c**, **d** *Dorsal* views showing *U*- and *V-shaped* anterior profiles of heads and differences in head widths. **e**, **f** *Frontal* views showing larger mouth and gape width of large mouth morph. **g**, **h** *Ventral* views showing *U*- and *V-shaped* anterior profiles of heads and larger head and gape width in the large mouth morph

Discussion

Morphometric and qualitative characters

By employing three morphometric measurements (Table 2) and four qualitative characters (Table 3), we were able to identify the three morphs of *T. newnesi* in samples from both Potter Cove and McMurdo Sound. The values for the morphometric measurements were statistically significant among the morphs at both localities (Table 2), and, with the exception of gape width/HL, the magnitude of their values were similar. The discordant values for gape width/HL ratios in specimens from the two localities were not unexpected because measurements of fish from each location were taken independently in different laboratories. There is not a precise fixed point for measuring gape width, and thus more inter-investigator variation is introduced. With the exception of colour, the utility of these characters has been recognized in previous studies (Eastman and DeVries 1997; Piacentino and Barrera-Oro 2009), but they had never been subject to statistical validation involving samples from different localities.

Knowing the degree of reliability of the morphometric measurements for separating the morphs, we converted them to qualitative characters, and knowing the variability in the qualitative characters, we employed the least variable characters in the first position in the couplets of the key. The key does not require making measurements.

Utility of colour for identification of morphs

Although colour can be a variable, and sometimes ephemeral, taxonomic character in fish, our data indicate that

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Fig. 2 Typical (**a**, **d**), intermediate (**b**, **e**) and large mouth (**c**, **f**) morphs of *Trematomus newnesi* from Potter Cove showing pattern of blotching and bright colour in living specimens (**a**–**c**) and the less distinct blotching and dulling of colour in similarly sized specimens 1.5 h after death (**d**–**f**)

Fig. 3 *Trematomus newnesi* from Potter Cove showing predominant colour of morphs in life. Large mouth morph is olive green (**a**–**d**), typical morph is *dark orange-brownish* (**e**–**f**) and intermediate morph has a colour between that of the other two morphs (**g**–**h**) (colour figure online)

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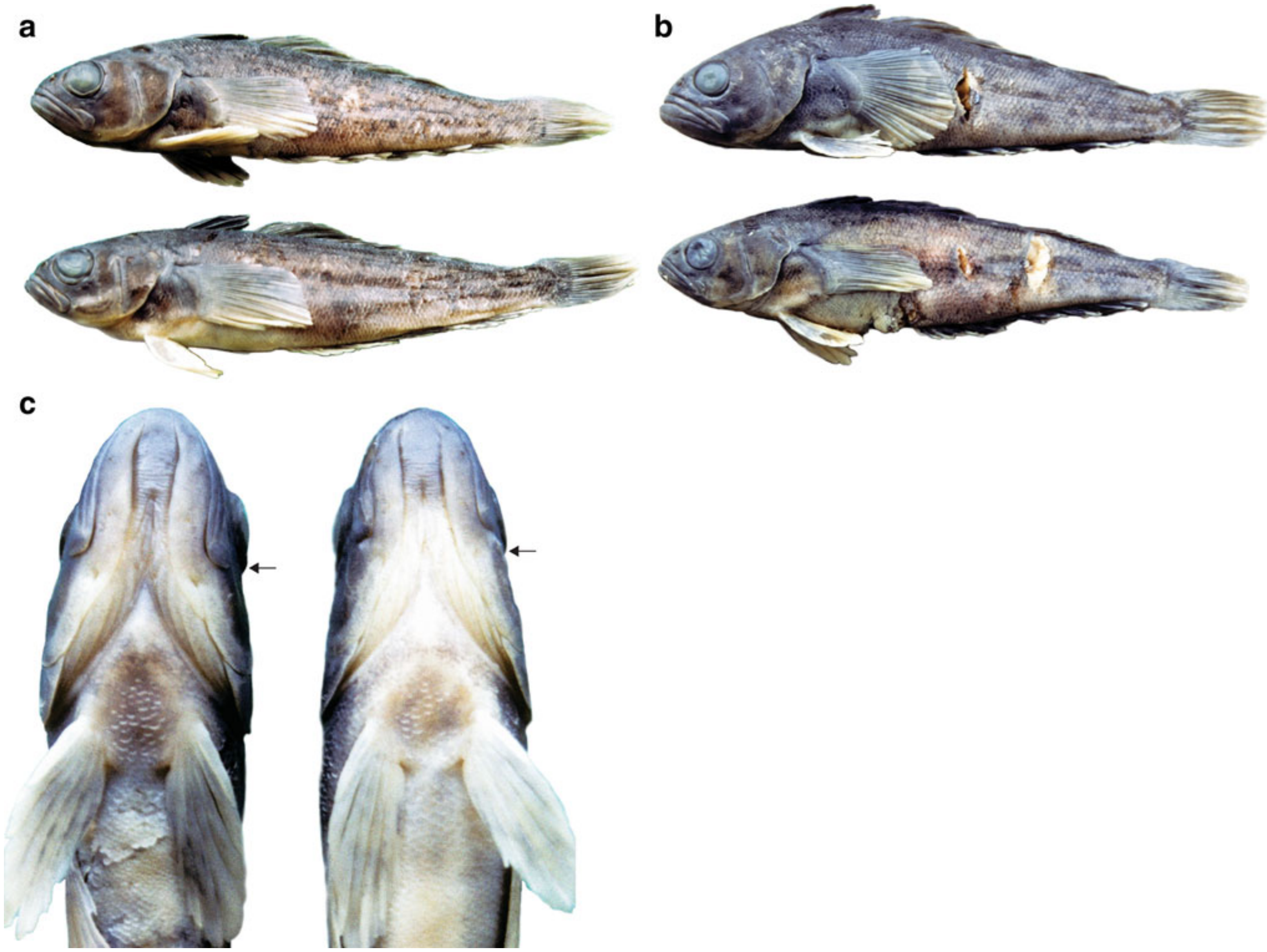

Fig. 4 Similarly sized morphs of *Trematomus newnesi* from McMurdo Sound. Specimens were fixed in formalin for several days and then stored in ethanol for 60 days prior to being photographed. Notice the predominantly muted colour and relatively inconspicuous blotching compared to morphs from Potter Cove. **a** Large mouth (*top*) and intermediate (*bottom*) have similar body shapes in this view,but the greater upper jaw length is evident in the large mouth morph. **b** Large mouth (*top*) and typical (*bottom*) morphs showing greater head depth and longer upper jaw of large mouth morph, and lighter ground colour in typical morph. **c** Large mouth (*left*) and intermediate (*right*) morphs (same specimens as in a) showing that the intermediate morph has a shorter upper jaw (*arrows*) and narrower gape width but has nearly the same head width across the opercles and the same *U-shaped* head profile as the large mouth morph. Note the darker ventral colouration in the large mouth morph

when carefully evaluated, it is useful in identifying morphs of *T. newnesi* from Potter Cove and possibly from other locations. Colour may vary with habitat or depend on the elapsed time after capture or type of preservation (freezing vs. fixation in formalin). The photographs of McMurdo morphs taken on preserved fish (Fig. 4) and of live Potter Cove morphs (vivid colour, Figs. 2a, c, e, 3), and 1.5 h later on dead fish (dull, faded colour, Fig. 2b, d, f) illustrate some of the possible influences on colour. Consequently, our observations here on living specimens differ somewhat from previous studies in which observations were made on dead fish some hours after capture or on frozen fish (e.g. Eastman and DeVries 1997; Piacentino and Barrera-Oro 2009). Hence, we suggest that, in employing the character "colour" in the identification of *T. newnesi* morphs from any locality (key and Table 3), it should be determined on fresh fish shortly after capture.

Ecological implications of colour in morphs of *T. newnesi*

Many fish possess patches of dark pigment that differ from the base colour and that serve to obscure their natural outline and enhance resemblance to the background (Marshall 1966, p. 186). Among taxonomically diverse benthic fish, there are many examples of 4–5 dark lateral blotches against a lighter background, a pattern imparting crypsis through disruptive colouration (Armbruster and Page 1996; Whiteley et al. 2009). Benthic species are generally more cryptically coloured than pelagic species (Clarke and Schluter 2011), and intraspecific variation in colour and

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pattern are usually related to the amount of light and the nature of the substrate (Norman and Greenwood 1975, p. 204–205). The common pattern of dark blotches against a lighter background is seen in the benthic species of *Trematomus* including *T. newnesi*, where it differs among the morphs in Potter Cove.

Potter Cove morphs

In Potter Cove, *T. newnesi* occurs mostly on rocky bottoms with macroalgae beds. Here, macroalgal biomass is high in comparison with other areas in western Antarctic Peninsula and especially in the Ross Sea (Quartino and Boraso de Zaixso 2008). The most abundant macroalgae species at 10–30 m are the large Desmarestiales represented by *Desmarestia menziessi*, *D. anceps* and *Himantothallus grandifolius* (Quartino et al. 2001; Quartino and Boraso de Zaixso 2008). The foliage of the first two species extends a maximum of 1 m into the water column. Although taxonomically classified as brown macroalgae or kelp, the Desmarestiales are predominantly greenish-brown in colour, similar to the general mottled olive green colour of the large mouth morph of *T. newnesi* (Figs. 1a, 2e) and *Notothenia coriiceps* and *Gobionotothen gibberifrons,* demersal-benthic fish species that are also found in this same habitat (EB-O, personal observations). Because they are negatively buoyant sedentary species (North 1996; Barrera-Oro 2002; Eastman and Sidell 2002), these latter two nototheniids probably remain on the bottom, sheltered within the understory of the macroalgae bed with their colour reflecting their macroalgae-dominated habitat. Given the colour similarity between the kelp and the large mouth morph of *T. newnesi*, *N. coriiceps* and *G. gibberifrons*, it is likely that this morph and the two other species coexist on the substrate within or near the vicinity of the understory of Desmarestiales macroalgae in Potter Cove.

In the typical morph of *T. newnesi* from Potter Cove, the dark blotches are smaller and less conspicuous, and the general dark orange-brownish colour (Figs. 1b, 2a) resembles the colour of the sympatric nototheniid *Notothenia rossii*, a semipelagic species (EB-O, personal observations). However, the colour of these two species cannot be related to the presence of red algae in the area (mainly *Iridaea sp.* and *Gigartina sp.*) because these algae species are not dominant and they are patchily distributed on the rocky bottom (Quartino et al. 2005). Therefore, we have no hypothesis for relating colour to habitat in the typical morph of *T. newnesi* and *N. rossii,* but we suspect that these fish are probably not closely associated with the Desmarestiales (greenish-brown) algae. This is consistent with the documented semipelagic lifestyle of *N. rossii* (Kock 1985; DeWitt et al. 1990) and the hypothesized semipelagic existence of the typical morph of *T. newnesi* (Eastman and DeVries 1997).

Interestingly, the blotching and colour of the intermediate morph (Figs. 2c, 3g, h) fall between those of the typical (lighter) and the large mouth (darker) morphs, but we have no data to support a hypothesis concerning a possible association of this morph with any type of macroalgae substrate or other habitat.

Overall, our finding of distinct differences in the colours of the large mouth and typical morphs at Potter Cove does offer, along with ecological inferences from morphological characters in Tables 2 and 3, correlative support for the original hypothesis of Eastman and DeVries (1997) that the large mouth morph is more benthic than the typical semi-pelagic morph.

McMurdo morphs

Pattern and colour vary only slightly among the morphs at McMurdo Sound compared with those at Potter Cove (Fig. 4a, b). Although the photos in Fig. 4 depict preserved specimens, the following statements about colour are also based on observations of fresh specimens (Eastman and DeVries 1997; Eastman, personal observations). Blotching is faint, and the background colour of all morphs is in the range of grey to dark grey. The large mouth morph is more uniformly and darkly pigmented, including ventrally (Fig. 4c), than the typical or intermediate morphs. Differences in blotching are not evident among the morphs. Ventral pigmentation is lighter in the typical and intermediate morphs (Fig. 4c), and some typical morphs have yellowish pectoral and caudal fins. Typical and intermediate morphs are similar and not distinguishable on the basis of colour (Fig. 4b), and, in general, colour is not a reliable character for distinguishing any McMurdo (Fig. 4a, b) and possibly other high Antarctic populations of *T. newnesi* morphs. Furthermore, high latitude notothenioids are usually not colourful, and, in the case of the McMurdo morphs of *T. newnesi*, there is no obvious association between colour and habitat. Brown macroalgae, for example, are not found in the High Antarctic, and benthic macroalgae in general are limited by low levels of light and substrate instability caused by ice abrasion and anchor ice (Heywood and Whitaker 1984; Dayton 1990). In the McMurdo area, red macroalgae of the genera *Phyllophora* and *Iridaea* encrust rocks or exist as mats on the substrate (Dayton 1990); hence, there is little vertical relief and no understory as exemplified by *Desmarestia menziessi* and *D. anceps* from Potter Cove in the Low Antarctic. Thus, we cannot recognize a macroalgae-associated morph among the McMurdo morphs.

A DVD movie “Fish under the Ice”, recently filmed by a ROV in Terra Nova Bay, a Ross Sea locality north of

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McMurdo Sound (Pisano et al. 2010), presents relevant views of the bottom and associated flora and fauna in an area covered by fast ice similar to that in McMurdo Sound. Among the notothenioids filmed, the epibenthic habitat and intermittent subcarangiform locomotion differentiate the semipelagic *T. newnesi* from the more benthic trematomids *T. bernacchii* and *T. pennellii*. A school of *T. newnesi* contains individuals with variable blotching, orange-reddish in lateral view and opaque/grey in dorsal view, which resemble the colour of the typical morphs at Potter Cove, and indicates that the blotched colour pattern is also present in high latitude populations. The total lack of kelp (demarestiales) is noteworthy, and although differentiation between morphs is not possible in the movie, no individuals of *T. newnesi* with the mottled olive green colour similar to that of the large mouth morph at PC were observed.

Conclusions

We expect that the availability of this key will encourage investigators working on *T. newnesi* to identify their samples to the level of the morphs. There are no documented differences in habitat, diet or buoyancy among the morphs of *T. newnesi* (Eastman and DeVries 1997; Eastman and Barrera-Oro 2010). We are hopeful that increased interdisciplinary awareness of this unique example of intraspecific ecophenotypic morphism in notothenioids will lead to research that eventually provides a causal explanation for the basis of this plasticity. To accomplish this, given that the specimens used in our study were collected within the relatively narrow depth range of 6–50 m (Table 1), it would be important to examine samples caught throughout the entire bathymetric range of this species. We also suggest that additional approaches, such as molecular genetics, cytogenetics and stable isotopic analyses of diets, should be used in future in comparative studies examining differences among and between the morphs.

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