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Variations in biological characteristics of temperate gonochoristic species of Platycephalidae and their implications: A review

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ABSTRACT

This review provides a composite account of the biological characteristics of the temperate gonochoristic species of the Platycephalidae. Initially, data were obtained for the five abundant platycephalid species in south-western Australia, which each came from either over bare substrata or seagrass and from either estuaries, marine coastal waters or marine embayments. The von Bertalanffy growth curves for females and males of each species differed significantly, with females having a greater TL_{∞} and lower growth coefficient k. From tests using their upper deciles, the total length (TL) attained by the largest females of each species was significantly greater than that of their males, whereas such a trend did not occur with age. The ratio of females to males in each abundant age class, and overall, exceeded parity for four of the five species (typically $P < 0.001$) and increased with increasing TL. Mortality estimates, which were similar for each sex of each species, suggest that *Platycephalus speculator* has been substantially exploited in a seasonally-closed estuary in which it completes its whole life cycle. The above and other biological data for the five species were collated with those published previously for two of those species and five other platycephalid species in south-eastern Australia and one in Japan and another in the Suez Canal, yielding the following conclusions for gonochoristic species of the Platycephalidae. Females attain a larger size than males, the extent varying markedly among species, whereas the longevities of the two sexes of each platycephalid species are similar. The maximum TLs and ages of the various species range widely, with values for females, for example, extending from 221 mm for *Ambiserrula jugosa* to 985 mm for *Platycephalus fuscus* and from four years for *A. jugosa* to 26 years for *Platycephalus conatus*. The overall ratio of females to males is positively related to the extent to which both the maximum TLs and TL_{∞}s of the females exceed those of males. The above trends imply that growth, rather than differences in longevity and/or mortality, is the main factor contributing to the marked differences in sex ratios, which ranged widely from parity to 3.2:1. As the length at maturity, but not typically age at maturity, was greater for females than males, maturity is also related mainly to growth. The spawning periods of the various species overlapped, commencing as early as late winter/early spring, as temperatures started rising with four species and later in late spring/early summer with the three species found in estuaries, which would be advantageous as spawning in estuaries would occur when environmental conditions are most favourable for spawning success and larval retention.

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1. Introduction

The Platycephalidae is found almost exclusively in the Indo-West Pacific (Nelson et al., 2016), where many of its species are fished commercially and/or recreationally (Masuda et al, 1991; Gray et al., 2002; Henry and Lyle, 2003; Sabrah et al., 2015; Patterson et al., 2016). This family comprises 18 genera and ~80 species, among which 15 genera and ~45 species have been recorded in Australian waters and within which 16 belong to the genus *Platycephalus*, which typically have a temperate distribution (Gomon et al., 2008; Imamura, 2015; Nelson et al., 2016). Although platycephalids are usually gonochoristic, at least two of their species in Japanese waters are protandrous hermaphrodites (Fujii, 1970, 1971; Shinomiya et al., 2003). Comparisons of published data (e.g. Jordan, 2001; Barnes et al., 2011; Gray and Barnes, 2015) suggest that, among platycephalid species in south-eastern Australia, the females tend to grow to a larger size, but not necessarily live longer, than their males. Although the sex ratio typically favours females, the extent of that difference varies among species.

As Wenner (1972) showed, in his seminal review of sex ratios in marine crustaceans, it is important, when discussing sex ratios, to have established whether the ratio of females to males of a species remains similar among length classes or changes in a consistent manner with increasing body size. Wenner (1972) concluded that the specific relationship of the numbers of females to males reflects the ultimate physical sizes that result from factors such as differential growth, longevity and mortality of the two sexes. There has been no attempt, however, to explore statistically whether a tendency for the females of platycephalids to be more numerous than their males is related to their growth to a larger size, lesser mortality and/or greater longevity.

The several platycephalid species studied thus far in the mid-southern and south-eastern Australian coasts are gonochoristic and well represented either over bare substrata or in seagrass located in either coastal marine or estuarine waters (Klumpp and Nichols, 1983; Jordan, 2001; Gray and Barnes, 2015). The studies on *Platycephalus speculator* in south-western Australia (Hyndes et al., 1992a, b), and preliminary unpublished results by the senior author for the other four abundant species in this microtidal region demonstrate that all five of these species are gonochorists. *Platycephalus speculator* completes its life cycle in marine embayments and coastal waters, and in seasonally-closed estuaries, such as Wilson Inlet, in which it is frequently associated with seagrass (Lenanton and Potter, 1987; Hyndes et al., 1992a, b; Potter and Hyndes, 1994, 1999; Gomon et al., 2008). Among the other four abundant species, whose biology has not been studied in detail in south-western Australia, *Platycephalus westraliae*, previously recorded as *Platycephalus endrachtensis* (Imamura, 2008), is numerous over sandy substrata and largely confined to the permanently-open Swan River Estuary (Potter et al., 1990; Potter and Hyndes, 1999). As estuaries are the most productive of marine environments (Schelske and Odum, 1961; Contanza et al., 2007), they facilitate rapid growth of the juveniles of marine species, and thus presumably also of those of estuarine residents, thereby likewise reducing the susceptibility of these young fish to predation (Blaber and Blaber, 1980; Kennish, 1990; Able and Fahay, 2010; Veale et al., 2016). *Platycephalus grandispinis*, previously recorded as *Platycephalus longispinis* (Imamura, 2013), is abundant over bare substrata in protected coastal marine waters on the lower west, south and south-eastern coasts of Australia (Valesini et al., 1997; Platell and Potter, 1998; Barnes et al., 2011), which, on the basis of the densities of its nematode and macroinvertebrate faunas (Wildsmith et al., 2005, 2011; Hourston et al., 2011), are far less productive than the Swan River Estuary. The remaining two abundant species, *P. laevigatus* and *L. inops* are found in large embayments on the south coast of Western Australia, and particularly in association with seagrass (Coulson et al., 2014, 2015), with the former also found in seagrass in south-eastern Australia (Klumpp and Nichols, 1983).

Platycephalus westraliae and *P. speculator*, which attain total lengths (TL) of ~1 m (Hutchins and Swainston, 1986), are fished recreationally and commercially (Smith, 2006; Ryan et al., 2015), as are certain other *Platycephalus* species in estuaries and coastal marine waters elsewhere in Australia and in Japan (Gray et al., 2002; Stokie and Talman, 2003; Koopman et al., 2004; Lyle et al., 2007; Barnes et al., 2011). In the context of estuaries, the Estuary Cobbler *Cnidoglanis macrocephalus* in the seasonally-closed Wilson Inlet, which contains one of the largest commercial estuarine