

## Correcting widespread misidentifications of the highly abundant and commercially important sardine species *Sardinella lemuru* in the Philippines

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### Summary

Morphology, meristics, and molecular genetics tools were used to determine the species level identification of the most commonly landed sardine species in the Philippines. Results from this study indicated that the historical and widely applied nomenclature of the Indian oil sardine, *Sardinella longiceps*, is incorrect and that this species is instead the Bali sardinella *Sardinella lemuru*. Developing an effective strategy for managing one of the Philippines most important commodity sardine species first requires accurate identification of this species. Results of this study provide needed information that is now being applied to emerging management policies.

### Introduction

Sardines are, and have been, the dominant landed fishes in the Philippines for the past two decades (Barut et al., 2003). They contribute billions of pesos in domestic economic revenue (Bureau of Agricultural Statistics, 2011) and serve as one of the most accessible sources of animal protein to millions of Filipinos (FAO, 2011). Sardines are a fast-growing, widespread species with high fecundity; species with these life-history characteristics will likely fair well as the seas warm in response to climate change (Gaughan and Mitchell, 2000; Clarke and Gorley, 2006). Thus, as food security moves to the forefront of national priorities, precedence should be given to establishing and managing a sustainably-harvested sardine fishery. Intuitively, developing an effective strategy requires first knowing which species are to be managed, yet considerable confusion surrounds which species are present in the Philippines. For the most common genus of sardines in the Philippines, *Sardinella*, Herre (1953) originally identified 11 species of sardines. This number was reduced to seven species by Conlu (1986), and, most recently, Quilang et al. (2011) revised this to nine species, while Willette et al. (2011a) recognized only six species. Consistently included in the first three reports is the presence of the Indian oil sardine, *Sardinella longiceps*, the most abundant and commonly landed sardine species in the Philippines according to government databases (Willette et al., 2011b; Bureau of Agricultural Statistics, 2011). It is uncertain why *S. longiceps* has been included in lists of Philippine *Sardinella* species, except perhaps that it has historically been a frequently studied sardine species (Hornell, 1910; Hornell and Nayudu, 1924). The earliest report citing the presence of *S. longiceps* in the Philippines, specifically Manila Bay, is a short narrative 1908 article in the Philippine Journal of Science (Seale, 1908). Seale reported about 13 species of

herrings occurring in Philippine waters, but specified only three species of sardines *S. longiceps*, *S. moluccensis*, and *S. gibbosa* [all listed in genus *Harengula*]; no measurements for diagnostic morphological features were provided.

*Sardinella longiceps* is commonly cited as a member of the Philippine sardine fishery (Ingles and Pauly, 1984; Dalzell et al., 1990; Ganaden and Lavapie-Gonzales, 1999; Samonte et al., 2000, 2009; Quilang et al., 2011), yet discrepancies exist when considering the known geographic range of the Indian oil sardine. *Sardinella longiceps* is endemic to the Indian Ocean and has a range extending from eastern Africa north to the Gulf of Oman and Gulf of Aden, along the Indian coastline to Sri Lanka and possibly as far east as the Andaman Sea (Whitehead, 1985). The range of *S. longiceps* does not include the Philippines; however, the range of a morphologically similar species, *S. lemuru*, does. The Bali sardinella *Sardinella lemuru* occurs from southern Japan, throughout Taiwan, the Philippines, across Indonesia to its southern limit in western Australia. This range was correctly listed in Munroe et al. (1999). Its westernmost limit is the Andaman Sea, a potential region of overlap with *S. longiceps*. *Sardinella longiceps* and *S. lemuru* can be distinguished from all other Indo-Pacific species of *Sardinella* primarily by the presence of nine pelvic-fin rays [one unbranched, eight branched] and subsequently by the combination of high counts of lower gillrakers, absence of a black spot at the dorsal-fin origin, presence of a black spot at the posterior opercular margin, and a faint gold stripe down the flanks preceded by a faint gold spot at the operculum (Whitehead, 1985). Apart from their near-geographic separation, distinguishing between *S. lemuru* and *S. longiceps* relies on two features: gillraker counts on the lower limb of the gill arch [77–188 in *S. lemuru*, 150–253, but typically 180–253 in *S. longiceps*] and the differences in their head lengths [26–29% of SL in *S. lemuru*, 29–35% of SL in *S. longiceps*] (Whitehead, 1985).

Here we set out to correctly and conclusively identify the most abundant species of *Sardinella* occurring in the Philippines using a combination of morphological and meristic characters and molecular genetics tools. Our study included samples from throughout the Philippines and a location in Indonesia near the type locality of the Bali sardinella. It is our intention that these findings be applied to current discussions regarding management of the Philippine sardine fishery.

### Materials and methods

Morphological measurements and meristic values were taken from 10 specimens sampled from a municipal fish landing site