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BRIEF COMMUNICATIONS

Indirect estimation of oxygen and food consumption in bonito, *Sarda chiliensis* (Scombridae)

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This paper presents an indirect approach to the estimation of oxygen consumption in the bonito, *Sarda chiliensis* (Cuvier, 1831), kept in aquaria, based on an estimate of the amount of water moved across their gills when swimming and a likely rate of oxygen extraction. The corresponding food consumption is estimated through oxycalorimetric conversion.

Magnusson & Prescott (1966) observed *S. chiliensis* of 56.8 cm mean F.L. (2530 g) kept at a temperature of 22° C at the Palo Verdes Aquarium, California, and reported them to swim an average of 69 km daily (i.e. 1.4 B.L. s⁻¹) with an average mouth aperture angle of 10–15°. We have estimated the amount of water that moved across their gills by first measuring, using a caliper, the frontal area of the mouth of *S. chiliensis* (i.e. gape, in cm²) when open at various angles (Fig. 1; Table I). From those data we derived the equation

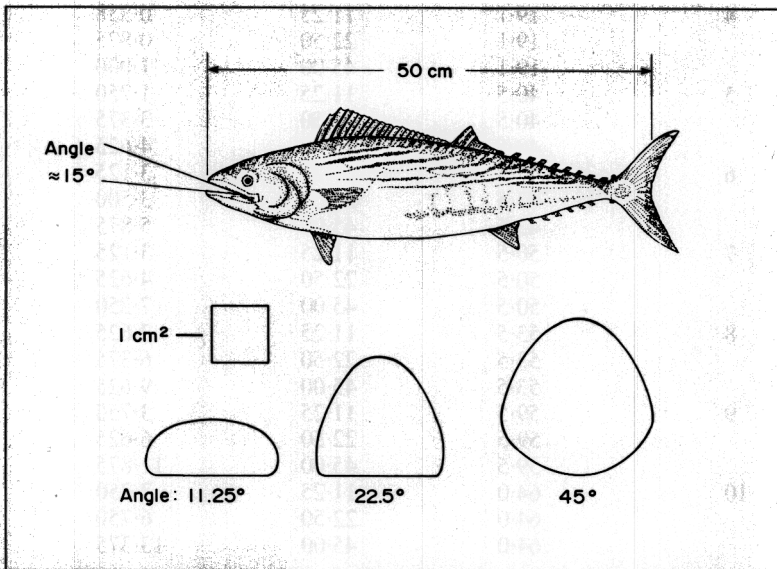


FIG. 1. Representation of a specimen of *Sarda chiliensis*, showing mouth aperture angle as defined in this contribution, and frontal area of mouth (= gape) for three different mouth aperture angles.

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$$\text{gape} = 0.000127 \text{F.L.}^{2.13} A^{0.705} \quad (1)$$

whose linear form has a high multiple correlation ($R=0.993$), and which allows a precise prediction of gape for any size (F.L., cm) and mouth opening angle (A) likely to occur in bonito.

Using equation (1), we predicted for our aquarium fish (F.L. = 56.8 cm and $A = 12.25^\circ$) a mean gape of 3.93 cm², which, multiplied by the distance swum and assuming no drag over the gills, corresponds to a value of 27 117 l of water moving daily across the gills of this fish.

We assumed that the sea water was oxygen-saturated (Magnusson & Prescott, 1966), i.e., it contained 5.22 cm³l⁻¹ of oxygen (UNESCO 1973), and that 50% of the oxygen content of sea water is extracted from the water passing across the gills of this scombrid (Stevens, 1972; Johansen, 1982). This gives an oxygen consumption of 27 117 × 5.2 × 0.5 = 70 775 cm³, or 4923 mg day⁻¹, which using an oxycaloric equivalent of 3.25 cal mg O₂⁻¹ (Brett, 1985),

TABLE I. Area of mouth opening (gape) as a function of body length and angle of jaw opening in 10 Peruvian specimens of *Sarda chiliensis*.

Specimen*	F.L. (cm)	Angle of mouth (°)	Gape (cm ²)
	10.4	11.25	0.088
	10.4	22.50	0.125
	10.4	45.00	0.250
	13.0	11.25	0.125
	13.0	22.50	0.375
	13.0	45.00	0.438
3	17.0	11.25	0.375
	17.0	22.50	0.625
	17.0	45.00	0.750
4	19.1	11.25	0.338
	19.1	22.50	0.875
	19.1	45.00	1.000
	40.5	11.25	1.750
	40.5	22.50	3.375
	40.5	45.00	4.625
6	43.5	11.25	3.125
	43.5	22.50	3.500
	43.5	45.00	5.875
	50.5	11.25	3.125
	50.5	22.50	4.625
	50.5	45.00	7.250
8	53.5	11.25	3.625
	53.5	22.50	6.375
	53.5	45.00	9.625
9	59.5	11.25	3.750
	59.5	22.50	6.625
	59.5	45.00	11.875
10	64.0	11.25	3.750
	64.0	22.50	6.750
	64.0	45.00	13.375

*Specimens 1–4 from IMARPE collection (courtesy Mr Juan Velez); 5 and 9 from Callao fish market; 6–8 from a Cuban vessel operating off Peru (courtesy Mr Juan Rubio); 10 from Trujillo fish market; 5–10 all collected in October 1986.

corresponds to 160 000 cal day⁻¹. Using the figure of 1000 cal g⁻¹ wet weight of prey (Winberg, 1956), the amount of food assimilated daily is calculated as 160 g, which, assuming an assimilation efficiency of 85% (Winberg, 1956), can be turned into an approximate value of food ingested of 160/0.85 = 188 g. The latter value corresponds, for fish of 2530 g, to a ration of 7.4% of body weight per day (%BWD).

Pauly *et al.* (1987) derived, based on stomach content analyses of bonito and metabolic considerations wholly independent of those above, the model

$$\%BWD = 1.45W^{-0.15}e^{0.115T}, \quad (2)$$

where W is bonito weight in g and T is the temperature in °C. This model predicts for $W = 2530$ g and $T = 22^\circ$ C a daily ration of 5.6% per day, which is close to the independent estimate based on gape measurements and oxycalorimetric conversion.

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