PROOF OF FORMULA 3.662.2

$$\int_0^{\pi/2} (\operatorname{cosec}\, x - 1)^{\mu}\, \sin 2x\, dx = \frac{(1-\mu)\pi\mu}{\sin \pi\mu}$$

Write

$$\int_0^{\pi/2} (\operatorname{cosec}\, x - 1)^{\mu}\, \sin 2x\, dx = 2\int_0^{\pi/2} (1-\cos x)^{\mu} \sin x \cos^{1-\mu} x\, dx.$$

The change of variable $t = \cos x$ gives

$$\int_0^{\pi/2} (\operatorname{cosec}\, x - 1)^{\mu}\, \sin 2x\, dx = 2\int_0^{1} (1-t)^{\mu} t^{1-\mu}\, dt.$$

This last integral is

$$2B(1+\mu, 2-\mu) = \frac{2\Gamma(1+\mu)\Gamma(2-\mu)}{\Gamma(3)},$$

and this simplifies to the stated answer.