Exploring a first-principles based model of zooplankton respiration

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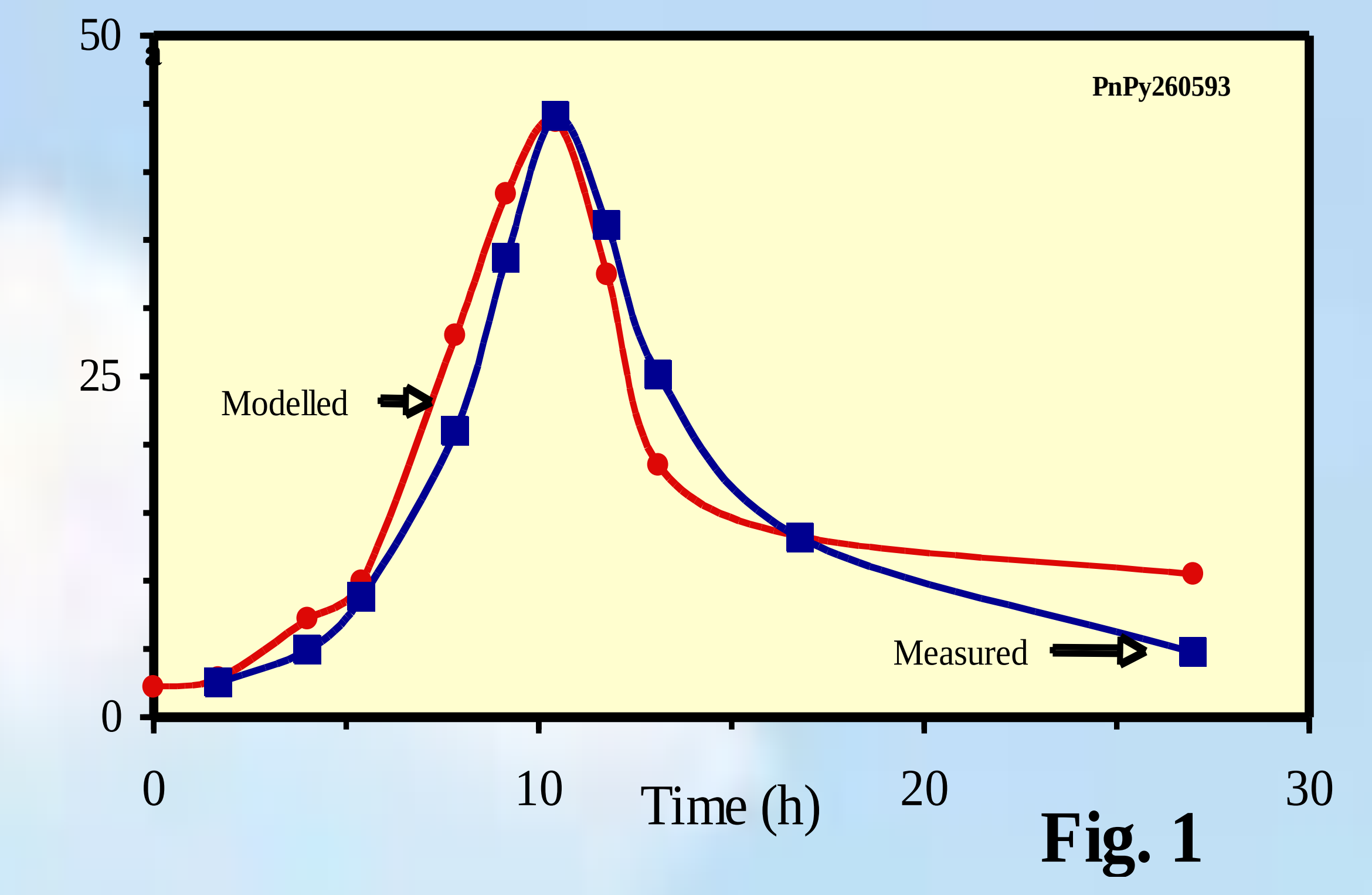

Fig. 1

Figs. 1 & 2. Modeling respiration from bisubstrate enzyme kinetics is feasible in Bacteria (1). For zooplankton, should we adapt this model or the MTE model? How does the MTE (Metabolic Theory of Ecology 2) do this? The MTE would predict respiration (R) by the following equation, R = i $M^{0.75}$, where i is a stoichiometric factor and M is the biomass (Fig 3).

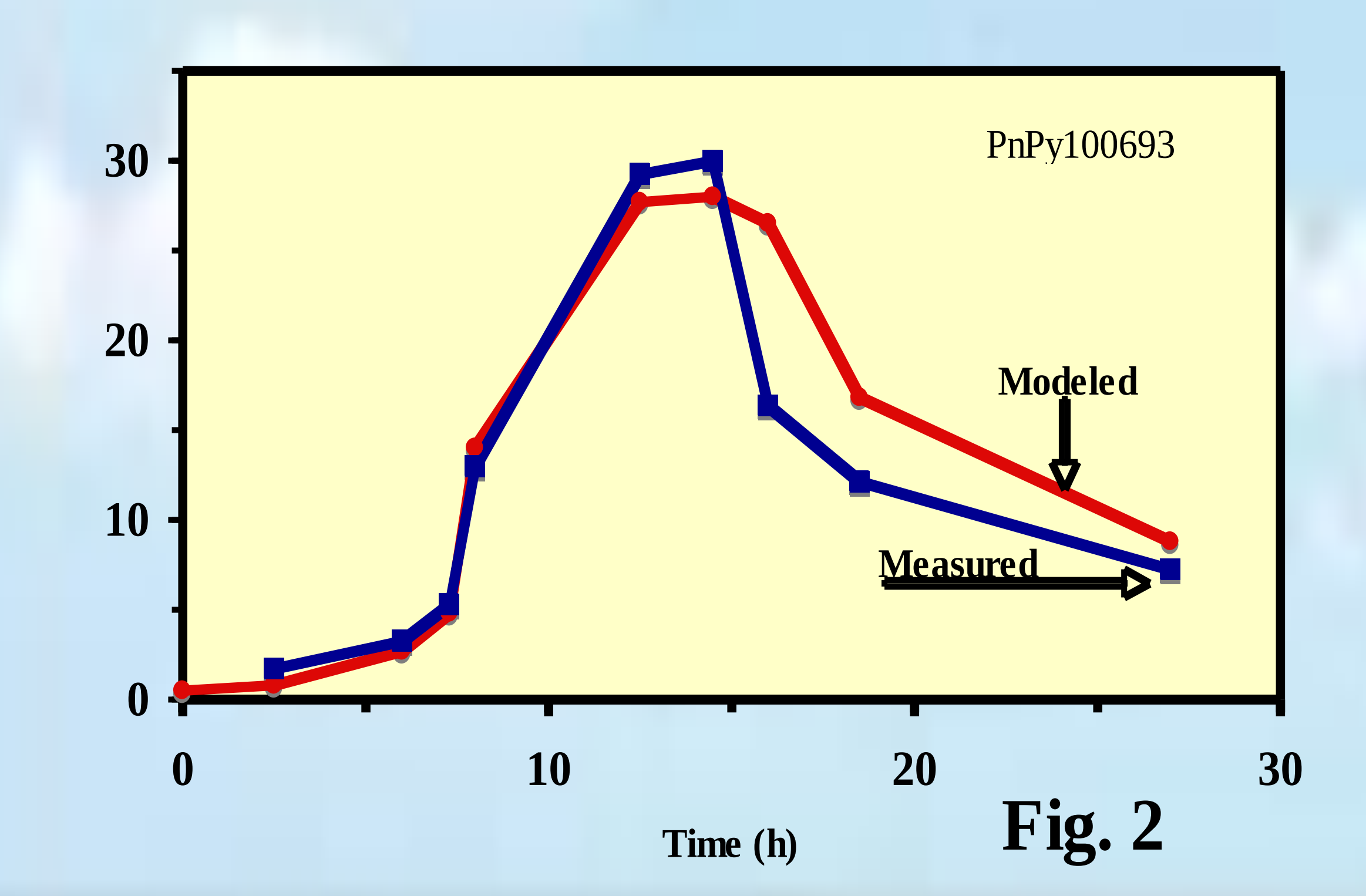

Fig. 2

Slide 1

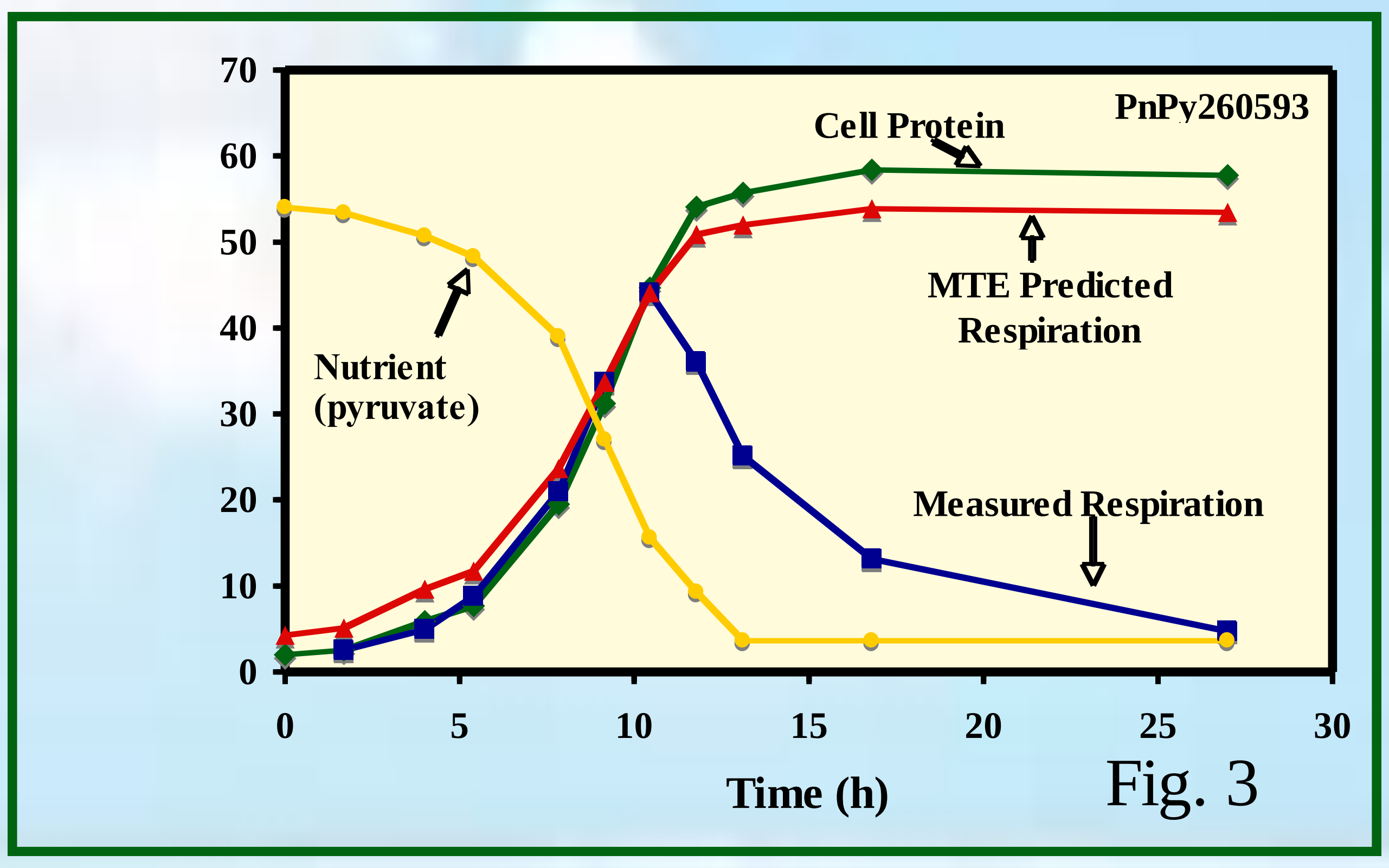

Fig. 3

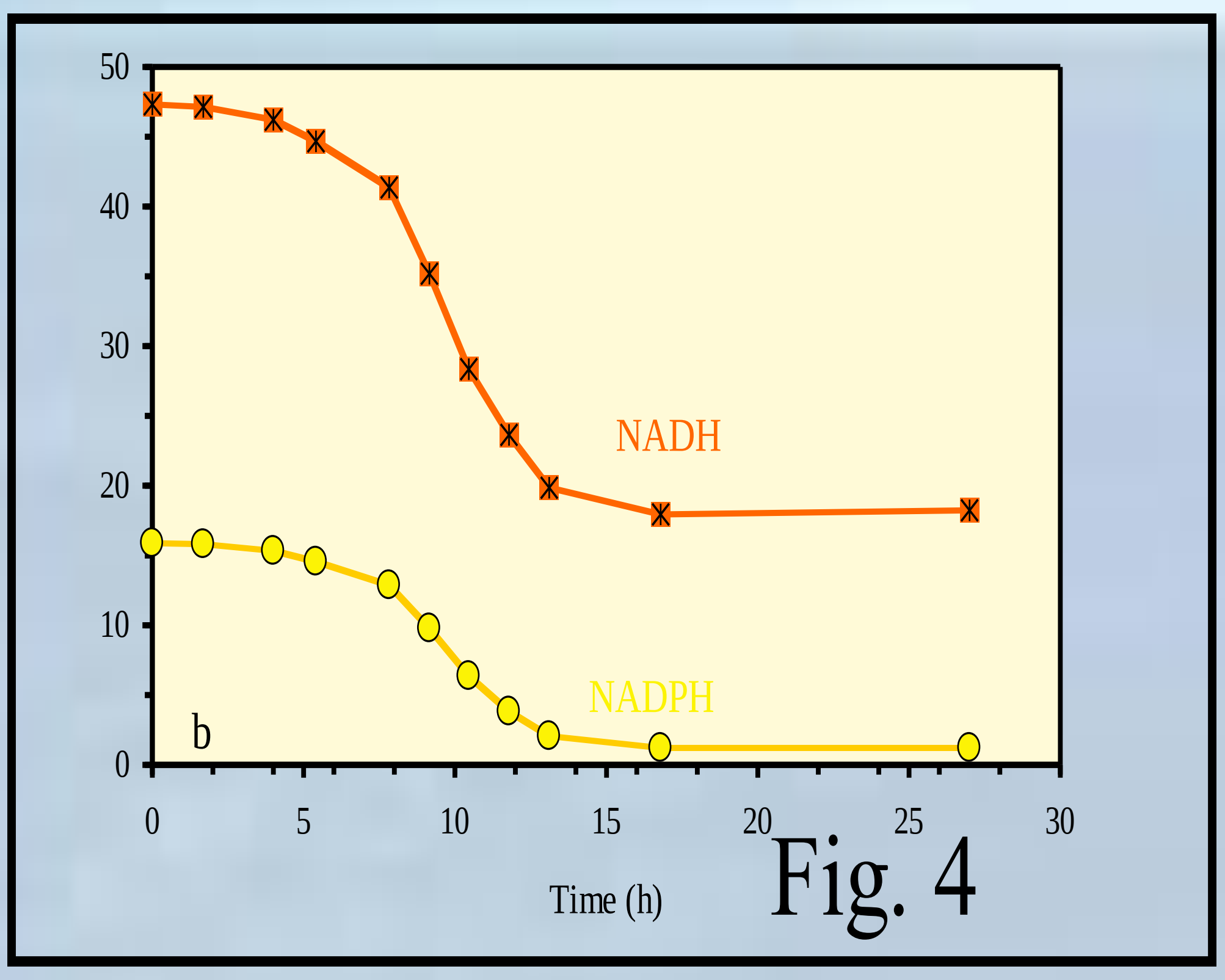

Fig. 4

But the MTE only predicts respiration when the food supply is adequate! Senescence respiration can't be predicted (Fig. 3)! Comparing Figs. 1 and 3 shows that clearly. How can your model predict respiration when food is scarce and respiration falls? Note parallelism in Fig. 3 between decreases in respiration and pyruvate (food source) during hour 10 to 13· Something in the food limits respiration. That's our hypothesis! Since enzymes control respiration, that "something" is the enzyme's substrates (Fig.4). Consequently, we argue that a respiration model should incorporate a Michaelis-Menten expression (Fig.5).

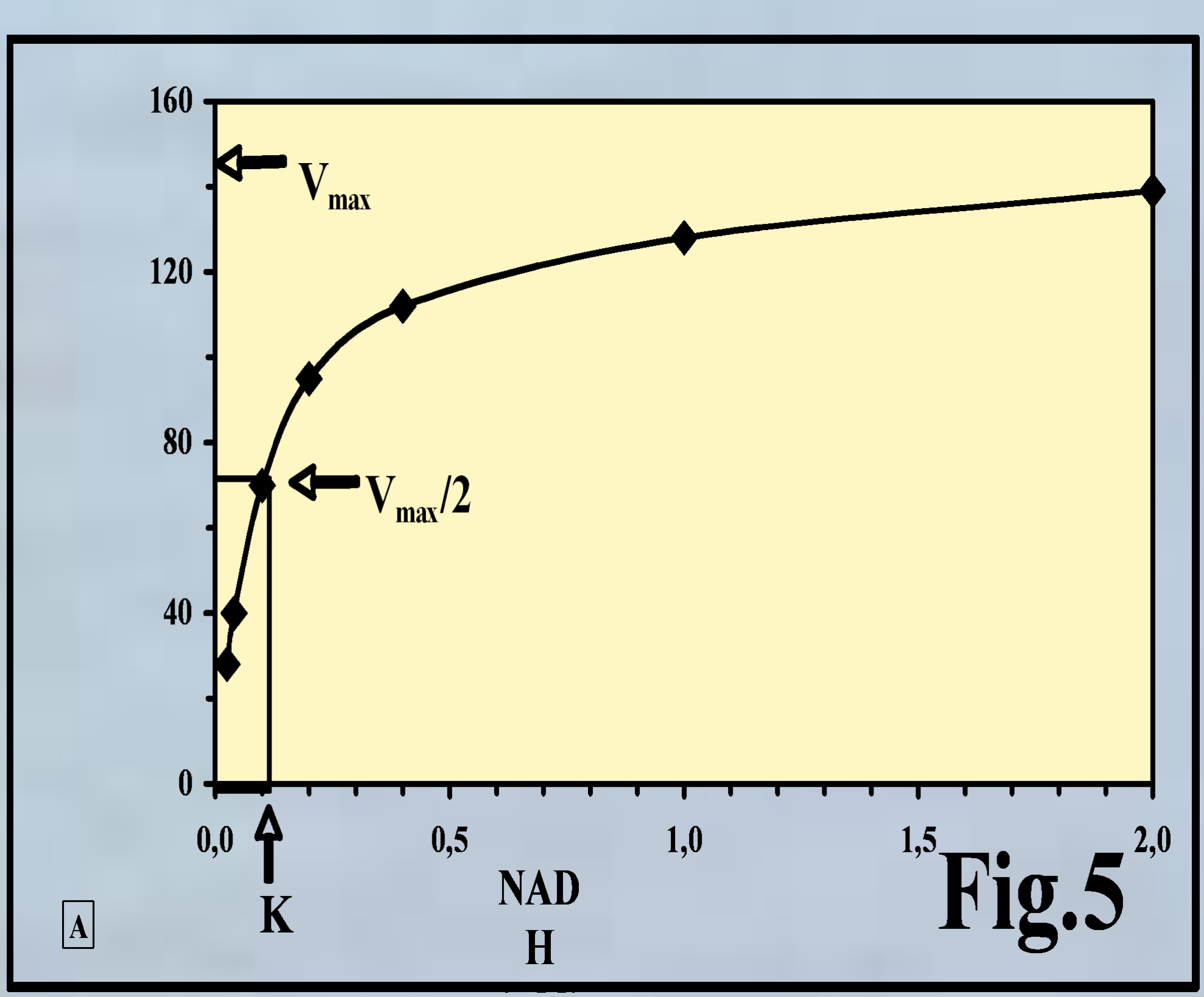

Fig.5

Our model is: $R_0 = SV_{max_0}/(K_m + S)$, where V_{max_0} isΦ, the potential respiration (ETS). We use Φ rather than $M^{0.75}$ because biomass just packages the ETS. The ETS is the real cause of respiration. Furthermore, the relationship between R and ETS is better and more direct than between R and M (Figs 6, & 7) .

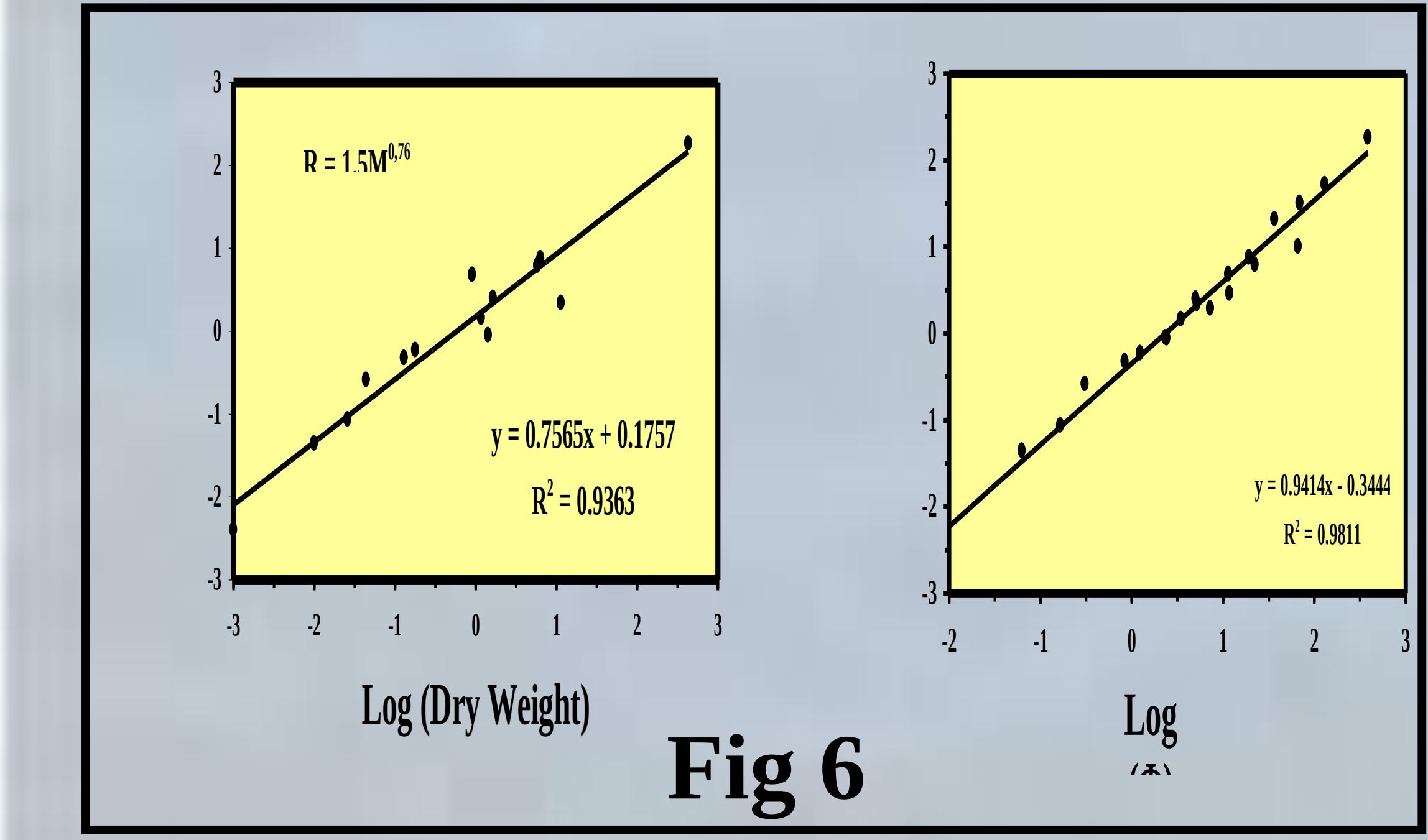

Fig 6

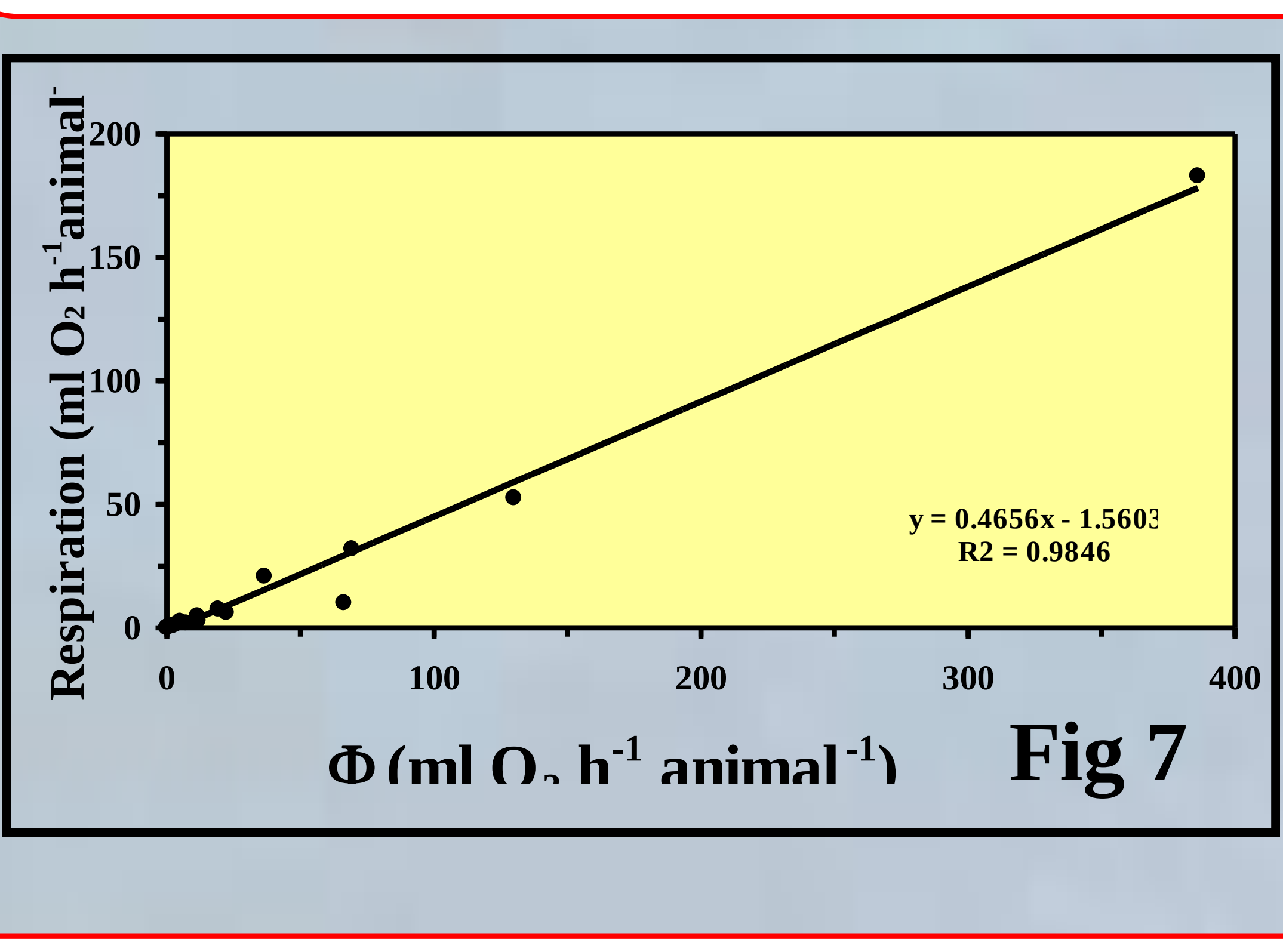

Fig 7

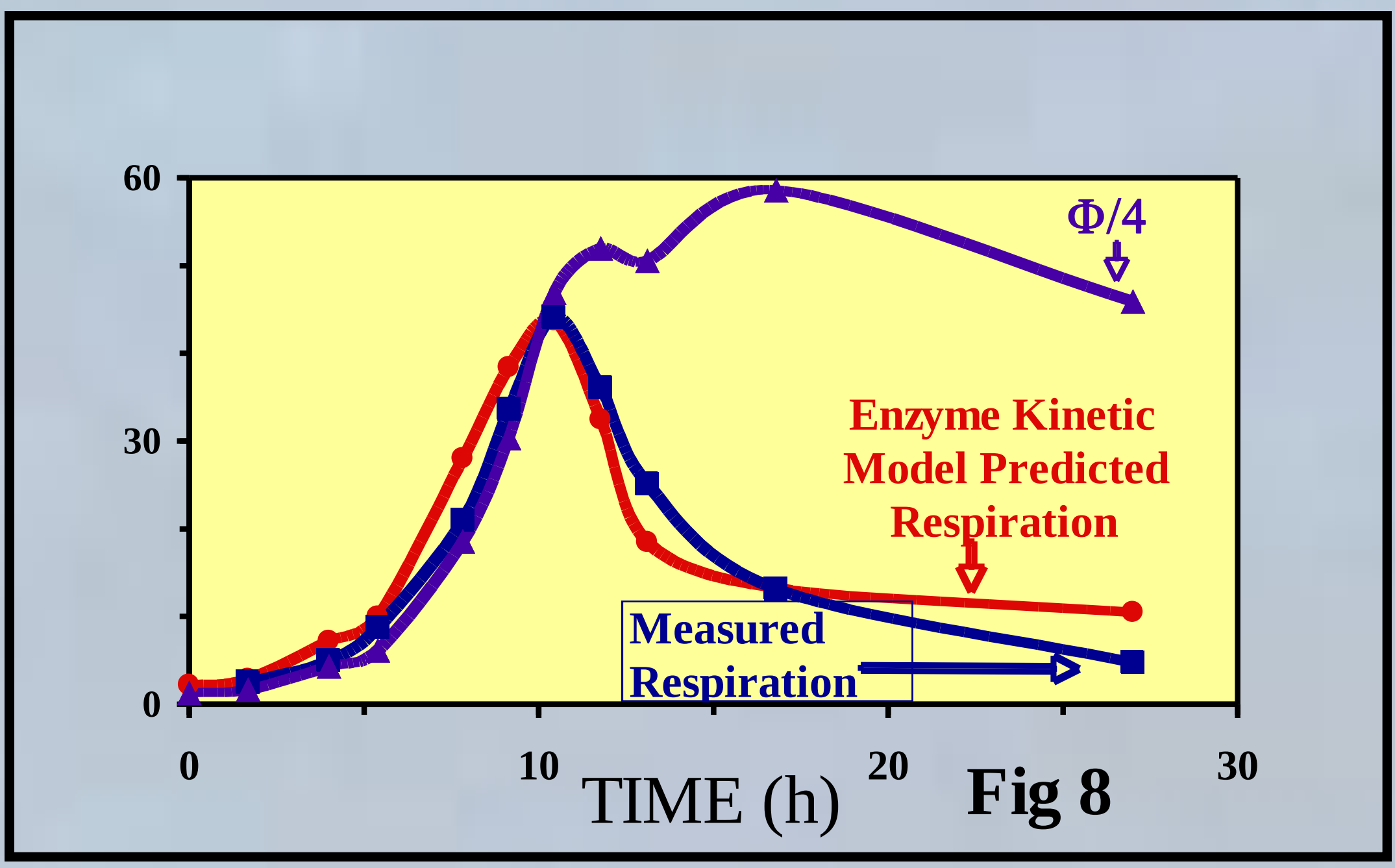

Fig 8

This model transforms Φ = f (Time) into R = f (Time) (Fig 8).

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