Hajime Kayanne et al. (1) investigate diurnal changes in CO2 partial pressure (P\(_{\text{CO2}}\)) and community metabolism on Shiraho reef (Ishigaki Island, Japan) and conclude that "reefs might serve as a sink, not a source, for atmospheric CO2," because of high net organic production relative to net calcification (Table 1). This conclusion is at odds with recent reports (2, 3, 4) and data (5) suggesting that reefs are net sources of atmospheric CO2, albeit of limited importance in the current carbon budget. Furthermore, it is well established that the value of gross primary production (P\(_{\text{g}}\)) is close to that of respiration (R) in most coral reef flats, and that the net production (P\(_{\text{n}}\)) is around zero (6). One would expect some reefs to depart from this general trend, but consideration of currents and community distributions suggests that the data in the report by Kayanne et al. (1) represent neither the whole Shiraho reef nor all coral reefs.

The reef flat at Shiraho comprises five different benthic communities and is under strong tidal influence (1, 7). Because Kayanne et al. measured P\(_{\text{CO2}}\) at a single station over several days, the water masses at hand had different origins and crossed different communities depending on the direction of the current. Therefore, the observed changes in P\(_{\text{CO2}}\) likely did not result from the metabolic activity of the entire reef flat but, rather, from a variable combination of the communities located around the study site.

Also, Kayanne et al. calculated mean daytime and nighttime reef water P\(_{\text{CO2}}\), with the use of a predictive regression equation

\[ P_{\text{CO2}} = 352 - 0.13 (I) \]

where \( I \) is light intensity, \( N = 13 \), and \( r^2 = 0.41 \). Our computation indicates that the local oceanic P\(_{\text{CO2}}\) (322 ppm) lies within the 95% confidence intervals for both values (daytime = 279 ± 103 ppm and nighttime = 352 ± 97 ppm), which prevents us from drawing any conclusion with regard to source versus sink.

Kayanne et al. measured community metabolism during slack-water periods. Kinsey (8, p. 439) pointed out that this technique provides metabolic parameters which are "related to a very precisely defined community because of the limited mixing which occurs with water from adjacent zones." Suzuki et al. (9) also used this technique and found P\(_{\text{n}}$/R = 1.4 at Shiraho reef (Table 1), a value much higher than those commonly found on reef flats [P\(_{\text{n}}$/R = 0.2 ± 0.3, that is, P\(_{\text{p}}$/0.3 ± 0.6]. The study site (1) seems to be located in an area dominated by algal turf and brown algae, which may explain the relatively high value for P\(_{\text{p}}$/R. Nakamori et al. (7) investigated the metabolism of various communities on the same reef and estimated production and calcification for the whole system. They found P\(_{\text{n}}$/R to be much less (\( \times 0.217 \)) than the value reported by Kayanne et al. (Table 1). The localized observations of Kayanne et al. (1) confirm well-known spatial and temporal variations of metabolic processes within reef ecosystems.

Calculations based on a recent model (4), and estimates of the larger community metabolism from Nakamori et al. (7), predict that the Shiraho reef was, at the time of measurement, a net source of CO2 for the atmosphere (with an evasion of 12 mmol CO2 m\(^{-2}\) d\(^{-1}\)).

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Table 1. Available data on community metabolism of the Shiraho coral reef (Ishigaki Island, Japan). Gross primary production (P\(_{\text{g}}\)), respiration (R) and net production (P\(_{\text{n}}\)) in mmol CO2 m\(^{-2}\) d\(^{-1}\); net calcification (G) in mmol CaCO3 m\(^{-2}\) d\(^{-1}\).

<table>
<thead>
<tr>
<th>Source</th>
<th>( P_{\text{g}} )</th>
<th>( R )</th>
<th>( P_{\text{n}} )</th>
<th>( G )</th>
</tr>
</thead>
<tbody>
<tr>
<td>T. Nakamori et al., 1992 (7)</td>
<td>302</td>
<td>278</td>
<td>24</td>
<td>60</td>
</tr>
<tr>
<td>H. Kayanne et al., 1995 (1)</td>
<td>—</td>
<td>—</td>
<td>110</td>
<td>100</td>
</tr>
<tr>
<td>A. Suzuki et al., in press (9)</td>
<td>460</td>
<td>320</td>
<td>130</td>
<td>160</td>
</tr>
</tbody>
</table>

REFERENCES


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Kayanne et al. (1) interpret their observations as evidence that coral reefs may be net sinks for atmospheric CO2, but specific and general evidence counter this interpretation.

Kühlmann (2, p. 19) described the Ishigaki Island reefs as "greatly stressed by human activity" and affected by siltation and agricultural chemicals. Anthropogenic stress increases the ratio of organic production to calcification, and the behavior of stressed or transitional reef communities is not representative of normal coral reef metabolism (3, 4).

Estimates of unstressed source-sink relationships can be derived from reef sediment characteristics. A carbon sink relevant to climate would have to take up atmospheric CO2 and sequester it from atmospheric exchange for centuries or millennia. Reef sediments provide an integrated view of the stored products of past reef metabolism. In a "pure" coral reef environment where organic-inorganic fractionation and nonreef contributions to sediments are negligible, a reef that is an atmospheric CO2 sink would have to deposit sediments that average more than 12 weight % organic matter or more than 6 weight % organic C [if one assumes 0.6 mol of CO2 evolved per mole of CaCO3 precipitated (5); one mole of CO2 consumed per mole of CH2O photosynthesized; and organic matter dry weight ~50% organic C]. However, organic C typically constitutes less than 1% of the dry weight of carbonate-dominated reef sediments (6). Biogenic carbonate skeletons normally contain only a few percent organic matter by weight (7).

Reef sediments thus far fall short of the composition required for a CO2 sink, which indicates that normal reef metabolism has probably been a net CO2 source during the recent geologic past. A reservoir of high-organic reef sediments that contained enough organic C to transform the system into a sink would have to be unrealistically rich in organic material in order to make up for the low organic C content of most sediment. Export of dissolved as opposed to particulate organic C (DOC/POC) from reef to ocean or export by downslope sediment transport would not provide a credible mechanism for differential sequestration of organic C that could account for the discrepancy.
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