Supplementary Materials: Hoving, H.J.T., S.L.Bush, S.H.D. Haddock, B.H. Robison. Bathyal Feasting: post-spawning squid as a source of carbon for deep-sea benthic communities. Proceedings of the Royal Society B

Table S1: Faunal associations, environmental data and locations of squid remains (carcasses, egg sheets) on the bottom of the Gulf of California. The number in parentheses after the Observation refers to the number of fragments observed in that frame grab. The numbers with letters after them (e.g. 9a and 9b) were also assumed to be from the same sheet because, while not in the same video frame, they were very close together. The ROV frame grabs on which these observations are based can be found at <http://mbari.org/squid-carrion-images>.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Observation** | **Associations** | **Dive** | **Latitude** | **Longitude** | **Obs. Depth (m)** | **Temp. (C)** | **Salinity (psu)** | **Oxygen (ml/l)** |
| 1 | Squid & Egg sheet | Asteroidea | D344 | 24.408966 | -109.883203 | 1250 | 3.49 | 34.58 | 1.661 |
| 2 | Egg sheet | Asteroidea | D344 | 24.409011 | -109.883191 | 1249 | 3.53 | 34.58 | 1.719 |
| 3 | Squid & Egg sheet | Decapoda, Asteroidea | D344 | 24.409134 | -109.88345 | 1247 | 3.54 | 34.58 | 1.915 |
| 4 | Egg sheet | Enteropneusta, Ophiuroidea | D378 | 26.359407 | -110.745092 | 2705 | 2.58 | 34.63 | 0.959 |
| 5 | Squid & Egg sheet | Decapoda, Ophiuroidea, Asteroidea | D386 | 27.589909 | -111.46962 | 1698 | 2.95 | 34.60 | 0.504 |
| 6 | Squid & Egg sheet | Ophiuroidea | D389 | 27.59662 | -111.468062 | 1666 | 2.95 | 34.60 | 0.508 |
| 7 | Egg sheet | Holothuroidea | D716 | 25.440811 | -109.850032 | 3016 | 2.31 | 34.63 | 1.530 |
| 8 | Egg sheet (4) | Asteroidea (on 1 fragment) | D730 | 24.408688 | -109.8826 | 1253 | 3.65 | 34.57 | 0.515 |
| 9a | Egg sheet | Decapoda | D730 | 24.408701 | -109.882621 | 1255 | 3.65 | 34.57 | 0.517 |
| 9b | Egg sheet | Asteroidea | D730 | 24.408698 | -109.882666 | 1254 | 3.66 | 34.57 | 0.512 |
| 10 | Squid carcass | Asteroidea | D730 | 24.408739 | -109.882729 | 1254 | 3.65 | 34.57 | 0.516 |
| 11 | Squid carcass | Asteroidea, Decapoda | D730 | 24.408093 | -109.882391 | 1259 | 3.65 | 34.57 | 0.514 |
| 12 | Egg sheet (4) | Decapoda (on 1 fragment) | D730 | 24.409116 | -109.882377 | 1259 | 3.65 | 34.57 | 0.514 |
| 13 | Squid carcass | Asteroidea, Decapoda | D730 | 24.408187 | -109.882338 | 1259 | 3.66 | 34.57 | 0.511 |
| 14 | Egg sheet | Decapoda  | D730 | 24.408126 | -109.882043 | 1262 | 3.67 | 34.57 | 0.504 |
| 15 | Squid & Egg sheet | Decapoda, Asteroidea | D730 | 24.40821 | -109.881983 | 1261 | 3.67 | 34.57 | 0.504 |
| 16 | Squid & Egg sheet | Asteroidea, Decapoda | D730 | 24.408475 | -109.882017 | 1258 | 3.68 | 34.57 | 0.502 |
|  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
| 17 | Egg sheet |  | D344 | 24.408296 | -109.883214 | 1250 | 3.53 | 34.58 | 1.616 |
| 18 | Egg sheet |  | D344 | 24.409028 | -109.883186 | 1249 | 3.53 | 34.58 | 1.721 |
| 19 | Egg sheet |  | D344 | 24.409165 | -109.883253 | 1248 | 3.49 | 34.58 | 1.793 |
| 20 | Egg sheet |  | D344 | 24.40918 | -109.883327 | 1247 | 3.51 | 34.57 | 1.854 |
| 21 | Egg sheet |  | D366 | 26.636461 | -111.015511 | 1559 | 3.03 | 34.61 | 0.479 |
| 22 | Egg sheet |  | D368 | 26.647463 | -111.030381 | 1616 | 2.99 | 34.61 | 0.483 |
| 23 | Egg sheet |  | D380 | 27.595668 | -11.487003 | 1565 | 2.94 | 34.61 | 0.506 |
| 24a | Egg sheet (2) |  | D386 | 27.590465 | -111.470216 | 1674 | 2.96 | 34.60 | 0.502 |
| 24b | Egg sheet |  | D386 | 27.590644 | -111.470592 | 1667 | 2.97 | 34.60 | 0.499 |
| 25 | Egg sheet |  | D387 | 27.591727 | -111.475949 | 1595 | 3.02 | 34.60 | 0.497 |
| 26a | Egg sheet |  | D387 | 27.590083 | -111.474759 | 1554 | 3.05 | 34.60 | 0.489 |
| 26b | Egg sheet |  | D387 | 27.590115 | -111.474739 | 1555 | 3.05 | 34.60 | 0.489 |
| 27a | Egg sheet |  | D387 | 27.590524 | -111.474977 | 1562 | 3.06 | 34.60 | 0.483 |
| 27b | Egg sheet |  | D387 | 27.590347 | -111.474939 | 1558 | 3.06 | 34.60 | 0.484 |
| 28 | Egg sheet |  | D387 | 27.589878 | -111.47485 | 1553 | 3.06 | 34.60 | 0.484 |
| 29 | Egg sheet |  | D387 | 27.589575 | -111.474629 | 1553 | 3.06 | 34.60 | 0.483 |
| 30 | Egg sheet |  | D389 | 27.59662 | -111.468062 | 1666 | 2.95 | 34.60 | 0.508 |
| 31 | Egg sheet |  | D389 | 27.596576 | -111.467651 | 1665 | 2.96 | 34.60 | 0.503 |
| 32 | Egg sheet  |  | D730 | 24.408714 | -109.882665 | 1255 | 3.65 | 34.57 | 0.516 |
| 33 | Egg sheet (2) |  | D730 | 24.408705 | -109.882669 | 1255 | 3.65 | 34.57 | 0.517 |

**Table S1 (continued).**

Table S1: Faunal associations, environmental data and locations of squid remains (carcasses, egg sheets) on the bottom of the Gulf of California. The number in parentheses after the Observation refers to the number of fragments observed in that frame grab. The numbers with letters after them (e.g. 9a and 9b) were also assumed to be from the same sheet because, while not in the same video frame, they were very close together. The ROV frame grabs on which these observations are based can be found at <http://mbari.org/squid-carrion-images>.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Observation** | **Associations** | **Dive** | **Latitude** | **Longitude** | **Obs. Depth (m)** | **Temp. (C)** | **Salinity (psu)** | **Oxygen (ml/l)** |
| 34 | Egg sheet |  | D730 | 24.408702 | -109.882698 | 1255 | 3.65 | 34.57 | 0.517 |
| 35 | Egg sheet |  | D730 | 24.408738 | -109.882729 | 1255 | 3.65 | 34.57 | 0.517 |
| 36 | Egg sheet (2) |  | D730 | 24.408769 | -109.882754 | 1254 | 3.65 | 34.67 | 0.515 |
| 37 | Egg sheet |  | D730 | 24.408841 | -109.882897 | 1252 | 3.65 | 34.57 | 0.514 |
| 38 | Egg sheet |  | D730 | 24.408851 | -109.882936 | 1252 | 3.65 | 34.57 | 0.515 |
| 39 | Egg sheet |  | D730 | 24.408868 | -109.882988 | 1251 | 3.65 | 34.57 | 0.515 |
| 40 | Egg sheet |  | D730 | 24.408877 | -109.88302 | 1251 | 3.65 | 34.57 | 0.515 |
| 41 | Egg sheet (2) |  | D730 | 24.408763 | -109.882989 | 1253 | 3.65 | 34.57 | 0.515 |
| 42 | Egg sheet (2) |  | D730 | 24.40875 | -109.882989 | 1253 | 3.66 | 34.57 | 0.513 |
| 43 | Egg sheet |  | D730 | 24.408717 | -109.882987 | 1252 | 3.66 | 34.57 | 0.513 |
| 44 | Egg sheet |  | D730 | 24.408686 | -109.882988 | 1254 | 3.66 | 34.57 | 0.514 |
| 45a | Egg sheet |  | D730 | 24.408579 | -109.882953 | 1254 | 3.65 | 34.57 | 0.514 |
| 45b | Egg sheet |  | D730 | 24.408401 | -109.882932 | 1254 | 3.65 | 34.57 | 0.515 |
| 46 | Egg sheet (2) |  | D730 | 24.408278 | -109.882981 | 1254 | 3.65 | 34.57 | 0.515 |
| 47 | Egg sheet |  | D730 | 24.407971 | -109.883055 | 1254 | 3.65 | 34.57 | 0.515 |
| 48a | Egg sheet (3) |  | D730 | 24.407934 | -109.882896 | 1255 | 3.65 | 34.57 | 0.514 |
| 48b | Egg sheet |  | D730 | 24.407937 | -109.88282 | 1256 | 3.65 | 34.57 | 0.515 |
| 48c | Egg sheet |  | D730 | 24.40794  | -109.882794 | 1256 | 3.65 | 34.57 | 0.515 |
| 49 | Egg sheet (2) |  | D730 | 24.407945 | -109.882677 | 1257 | 3.65 | 34.57 | 0.515 |
| 50 | Egg sheet |  | D730 | 24.408044 | -109.882438 | 1258 | 3.65 | 34.57 | 0.515 |
| 51 | Egg sheet (2) |  | D730 | 24.408093 | -109.882391 | 1259 | 3.65 | 34.57 | 0.515 |
| 52 | Egg sheet (4) |  | D730 | 24.408192 | -109.88234 | 1260 | 3.66 | 34.57 | 0.509 |
| 53 | Egg sheet |  | D730 | 24.408201 | -109.882182 | 1260 | 3.67 | 34.57 | 0.508 |
| 54 | Egg sheet |  | D730 | 24.408183 | -109.88214 | 1260 | 3.67 | 34.57 | 0.505 |
| 55 | Egg sheet |  | D730 | 24.408118 | -109.881986 | 1262 | 3.67 | 34.57 | 0.504 |
| 56a | Egg sheet |  | D730 | 24.40818 | -109.881966 | 1262 | 3.67 | 34.57 | 0.505 |
| 56b | Egg sheet (2) |  | D730 | 24.408192 | -109.881973 | 1261 | 3.67 | 34.57 | 0.504 |
| 57a | Egg sheet |  | D730 | 24.408281 | -109.881997 | 1260 | 3.67 | 34.57 | 0.503 |
| 57b | Egg sheet (2) |  | D730 | 24.408339 | -109.88201 | 1259 | 3.67 | 34.57 | 0.501 |
| 58 | Egg sheet (3) |  | D730 | 24.408393 | -109.882016 | 1259 | 3.67 | 34.57 | 0.503 |
| 59 | Egg sheet |  | D731 | 27.397239 | -111.872669 | 1072 | 4.29 | 34.56 | 0.196 |
| 60 | Egg sheet |  | D731 | 27.389693 | -111.872429 | 1296 | 3.62 | 34.58 | 0.353 |
| 61 | Egg sheet |  | D731 | 27.390011 | -111.872429 | 1287 | N/A | N/A | N/A |
| 62 | Egg sheet |  | D731 | 27.391654 | -111.872416 | 1246 | N/A | N/A | N/A |
| 63 | Egg sheet |  | D731 | 27.391734 | -111.872415 | 1243 | N/A | N/A | N/A |
| 64 | Egg sheet |  | D731 | 27.391889 | -111.872427 | 1239 | 3.66 | 34.58 | 0.337 |

SM1

**Calculations and estimations of carbon content and carbon contribution of squid carrion**

We assumed that each observation of an egg sheet (without a squid) represented a female squid carcass that had recently been consumed on the seafloor. The total carcass number on one dive was taken as the number of carcasses plus the number of egg sheet fragments. We also assumed that the observed squid carrion was the only carrion in that location that year, and we did not take into account scavenging rates. The bottom area covered during each of the ROV dives in Table S1 was calculated by reconstructing the ROV track in GIS using the stored coordinates (<http://mbari.org/squid-carrion-images>). The total distance traveled of the dives where carrion was encountered was between 88-3312 m (Table S2). We assumed a field of view of average 4 meters (based on measured field of view on dives when a laser was present on the ROV), and inserted this as buffer in GIS. The area observed was then calculated with the GIS feature correcting for overlap when the ROV crossed its previous track. The carcass density during one dive was calculated by dividing the estimate of the total carcass number with the area surveyed during that dive. From the carcass density we can calculate the total squid carcass weight per area using an estimated squid carcass weight. We measured the mantle length of two squid on the bottom with the lasers of the ROV (281 mm and 452 mm). Additionally, assuming that *Paralomis multispina* has a carapace size of 80 mm and the asteroid disk of *Nymphaster diomedeae* is 80 mm we estimated the ML of 5 more squid (327, 349, 314, 324, 407 mm ML) with Gimp 2. The calculated average ML of 351 mm corresponds to an average carcass wet weight of 1.9 kg , as derived from the published length-weight relationship of *Gonatopis octopedatus* (25). From total squid carcass weight per area, the squid carbon per area can be derived. In squid the dry weight is typically 22.5% of the wet weight (35). In cephalopods around 44% of the dry weight is carbon (*Loligo forbesi* 44% carbon of dry mass; 43-44% carbon dry mass of *Illex argentinus* (36). Therefore around 9.9% of the squid wet weight is carbon. (This is a conservative number compared to Bradford-Grieve et al., 2003 (35) who assumed squid carbon content to be 20% of the wet weight). The carbon associated with the squid carcasses was calculated by taking 9.9% of the weight of the squid carcasses, resulting in an squid carcass carbon contribution in mgC/m2. Assuming an annual pulse of carcasses and assuming that an observed carcass is the only carcass that falls on that location in that year (not taking into account scavenging rate), we can estimate the daily contribution of squid carbon in mgC/m2/day by dividing the mgC/m2 by 365 days. We did not include the egg sheet in our carbon calculations.

Table S2: Calculations of carbon flux associated with squid carrion. The estimated number of carcasses refers to the observations of squid carcasses plus the number of egg sheets. It is assumed that for each egg sheet a squid carcass was deposited and consumed by bottom scavengers. Squid carbon is calculated as 9.9% of the squid wet weight.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Date** | **Dive** | **ROV d (m)** | **Horizontal View (m)** | **Area (m2)** | **Estimated # Carcasses**  | **Carcasses/km2** | **Squid Weight (g)** | **Squid Carbon (g)** | **g C/m2** | **mgC/m2/day** |
| 2-26-2012 | D344 | 88.04 | 4 | 298.80 | 7 | 0.02343 | 13300 | 1316.7 | 4.41 | 12.07 |
| 3-28-2012 | D366 | 995.8 | 4 | 3262.55 | 1 | 0.00031 | 1900 | 188.1 | 0.06 | 0.16 |
| 3-29-2012 | D368 | 1307 | 4 | 4225.32 | 1 | 0.000237 | 1900 | 188.1 | 0.04 | 0.12 |
| 4-9-2012 | D378 | 3312 | 4 | 9635.55 | 1 | 0.000104 | 1900 | 188.1 | 0.02 | 0.05 |
| 4-10-2012 | D380 | 950 | 4 | 2235.85 | 1 | 0.000447 | 1900 | 188.1 | 0.08 | 0.23 |
| 4-13-2012 | D386 | 993.41 | 4 | 2933.32 | 2 | 0.000682 | 3800 | 376.20 | 0.13 | 0.35 |
| 4-14-2012 | D387 | 2025.74 | 4 | 5183.92 | 5 | 0.000965 | 9500 | 940.50 | 0.18 | 0.50 |
| 4-15-2012 | D389 | 1425.20 | 4 | 2831.91 | 3 | 0.00106 | 5700 | 564.30 | 0.20 | 0.55 |
| 2-28-2015 | D716 | 1579.48 | 4 | 6141.34 | 1 | 0.000163 | 1900 | 188.1 | 0.03 | 0.08 |
| 3-16-2015 | D730 | 692.88 | 4 | 2416.17 | 36 | 0.0149 | 68400 | 6771.6 | 2.80 | 7.68 |
| 3-21-2015 | D731 | 2405.68 | 4 | 7899.85 | 6 | 0.000760 | 11400 | 1128.6 | 0.14 | 0.39 |

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