The extra line of working for Eq. 5.15. From

$$
\begin{aligned}
Z_q\left(R\right) &= \int_{-\infty}^{\infty} \prod_{i=1}^{N} \left[dq_{i,i-1} \exp\left(-\frac{\Phi\left(q_{i,i-1}\right)}{kT}\right)\right] \frac{1}{2\pi} \int_{-\infty}^{\infty} d\omega \, \exp\left[i\omega\left(\sum_{j=1}^{N} q_{i,i-1} - R\right)\right] \\
&= \frac{1}{2\pi} \int_{-\infty}^{\infty} \prod_{i=1}^{N} \left[dq_{i,i-1} \exp\left(-\frac{\Phi\left(q_{i,i-1}\right)}{kT}\right) \exp\left(i\omega q_{i,i-1}\right)\right] \int_{-\infty}^{\infty} d\omega \, \exp\left(-i\omega R\right) \\
&= \frac{1}{2\pi} \int_{-\infty}^{\infty} d\omega \, \exp\left(-i\omega R\right) \left[\int_{-\infty}^{\infty} dq_{i,i-1} \, \exp\left(-\frac{\Phi\left(q_{i,i-1}\right)}{kT}\right) \exp\left(i\omega q_{i,i-1}\right)\right]^{N}
\end{aligned}
$$