Hint to Exercise 2.4.1

$\Xi_{\phi}$ is periodic under very general conditions (cf. [50]). Indeed, from Eqn. (2.38), we have

$$\Xi_k \big|_{l_0}^{\hat{p}_n} = \frac{\partial}{\partial J_k} \int \hat{p}_{\gamma}(q_1, J) \, dq_1 - \frac{\partial J_1}{\partial J_k} = 0 \quad (k > 2).$$