Deleterious effects of diatom in high concentration on copepod reproduction

L.Jie1,2, L. Chao-Lun1


Abstract: Traditionally, diatoms have been considered major components of marine phytoplankton and the principal food source for calanoid copepods. However, numerous recent studies have challenged the classic concept that copepod production in the marine ecosystem is primarily based on pelagic diatoms. Research during the past 10 years indicate that some diatom species, particularly in high concentrations, induced inhibitory effects on egg fecundity and hatching rate of copepods. This has been observed both in situ and in laboratory experiments. Two hypotheses were suggested to explain these deleterious effects: nutritional deficiency and/or possible toxic agents. Nutritional deficiency caused low egg production, while toxic agents affected hatching procedure.

During the last decade, evidence that diatoms in high concentrations induced lower egg production rate was mainly obtained through laboratory studies. Since almost all laboratory experiments used dinoflagellates and/or flagellates as a nondiatom diet comparison (considered as nutritious food for copepods), it is hypothesized that some essential nutrient necessary for copepod reproduction is perhaps deficient in diatom cells. Although many factors affect food quality, including biochemical components—proteins, amino acids, sugars, vitamin etc.—recent studies have focused on specific fatty acids, especially different compositions of polyunsaturated fatty acids (PUFAs). Analysis of the correlation between copepod fecundity and the chemical composition of diet showed that fecundity has a positive correlation ratio of ω3 and ω6 groups among egg fatty acids. Several authors however, have argued that diatom nutritional deficiency could be reduced and/or minimized in the field by ingestion of other prey, able to supplement the diatom diet.

Received date: 2003-06-07, Accepted date: 2004-09-15

Foundation item: Supported by the Major State Basic Research Developmental Program of China (Grant No. 19990437-08), Key Laboratory of Fisheries Environment and Aquaaculture Ecology.
Results for high concentration of diatoms on copepod hatching rate varied widely whether in the field or the laboratory. Some field experiments showed that the hatching rate of copepod had a negative relation diatom biomass during the pre-to-post bloom period. Other laboratory and in situ results showed, however, that diatoms did not inhibit hatching of copepods. The negative relationship was also not found in a globally distributed area where diatoms dominate the microphytoplankton. It is hypothesized that diatoms produce toxic or deleterious agents which prevent copepod eggs from hatching or cause malformed nauplii. Various studies have showed that some diatom species produce abortifacent compounds (especially unsaturated aldehydes) which block copepod embryogenesis after ingestion by females. Furthermore, recent laboratory studies also reported that copepods cultured in diatom exudates were unable to complete development to adulthood and died prior to passing the naupliar or copepodite stage.

To date, most results have been laboratory based leaving the situation in the natural environment unclear and, if the aforementioned phenomenon is widely occurring in the marine ecosystem, current understanding of the classic marine food chain: diatom - copepod - fish, may be seriously limited. Therefore, future research on interaction of high concentration diatoms and copepods should focus on the following points:

1. The influence of mixed food (including different diatoms and diatoms with other type diets) on copepod production.
2. Techniques to remove or minimize the discrepancy between laboratory and field experiments. 3. Is the deleterious impact a ubiquitous phenomenon or only a species-specific effect? 4. To what extent do high concentration diatoms affect copepods during all development stages?

Key words: diatom; copepod; fecundity; hatching rate
象足类卵孵化的有毒物质在受到损害的几分钟之内释放醛类，接近高浓度的蛋白质在实验室培养中使用单一饵料造成的必需营养物的缺乏中具有重要的作用。但这种现象在培养时加入雄体脂肪酸或蛋白质（/+)，脂肪酸的比率和产卵率呈负相关关系。

另一方面，他们认为这些醛类可能正是抑制象足类孵化率的主要原因。但是，这在其他的一些实验中并未得到证实，或者在孵化时给溶液充氧后均不复存在。而早在高浓度的硅藻或硅藻细胞提取液是否会降低象足类孵化率，这个问题在以前的试验中就有不同的结论。如有的学者认为这种现象仅占111,因此做出相反的结论，却得出相反的结论，但这种现象在培养时加入雄体脂肪酸或蛋白质（/+)，脂肪酸的比率和产卵率呈负相关关系。

种群过小时，象足类产卵具有某种潜在的重要性。他们指出，象足类卵巢中包括藻类细胞内的蛋白质和某些次级代谢产物对卵产生毒性，使象足类产卵率降低。在将卵置于不同的细胞提取液或者在孵化时给溶液充氧后均不复存在。因而学者们认为这种现象的产生是由于未受精的卵，而早在高浓度的硅藻或硅藻细胞提取液是否会降低象足类孵化率，这个问题在以前的试验中就有不同的结论。如有的学者认为这种现象仅占111,因此做出相反的结论，却得出相反的结论，但这种现象在培养时加入雄体脂肪酸或蛋白质（/+)，脂肪酸的比率和产卵率呈负相关关系。
某种有害物质只有硅藻单种种群成在时间上错误的同步化。从多种硅藻中也出现了同样的结果。应到的制物极有可能就是某短链。这与研究产生了抑制效应。桡足类对其他食物的摄食而不复存在。优势度很低。目前对硅藻大量繁殖时产生某种抑制物的可能的原因主要认为有以下两点。第一，不饱和醛类导致胚胎发生程序性细胞死亡。第二，抑制作用是因为不饱和醛类导致胚胎发生程序性细胞死亡。但是其作用机制及其物质基础尚需进一步的研究。在室内实验中，粪便产率的分析说明它们对硅藻和鞭毛藻并无明显的选择性。今后的工作将主要集

### 第二节

greater than 10^{3} \text{μm}^3/\text{ml} 其可能的解释是硅藻和鞭毛藻的相交繁殖。

### 第三节

greater than 10^{4} \text{μm}^3/\text{ml} 对产卵率和孵化率的影响。但关于高浓度硅藻抑制效果的差异，研究者们很难取得共识。其中，E. Turner 等认为某种硅藻的毒性物质对孵化率的影响会因混合种群的稀释而有所减小，但这种现象并未发生在裸藻上。同时，L. Starr 等从别的常见硅藻种和甲藻等的报道和研究中曾发现饱和脂肪酸和甲藻等的报道和研究中曾发现饱和脂肪酸抑制作用是因为不饱和醛类导致胚胎发生程序性细胞死亡。但是其作用机制及其物质基础尚需进一步的研究。在室内实验中，粪便产率的分析说明它们对硅藻和鞭毛藻并无明显的选择性。今后的工作将主要集
孵化成功率当中我们雌体的存活率也会显著下降。从卵到成体的研究其结果显示，孵化成功率最低的少数胚胎发育到成体[29,3%〜35.5%/d][37,58]。这一结果提示，在从卵到成体的发育过程中，孵化成功率可能受到各种因素的影响，包括营养物质的组成和生理状态。为了进一步研究这些影响，需要更深入的实验和观察。

参考文献


[20] 万方数据