

氏 名	アンドレアス ヘンドラチプタ クルニアワン Andreas Hendrapipta KURNIAWAN
本籍（国籍）	インドネシア
学 位 の 種 類	博士（農学）
学 位 記 番 号	連研第 706 号
学位授与年月日	平成 30 年 3 月 23 日
学位授与の要件	学位規則第 5 条第 1 項該当課程博士
研究科及び専攻	連合農学研究科 生物生産科学
学位論文題目	Possible effects of a mud snail, <i>Cipangopaludina chinensis laeta</i>, and temperature on performance of rice plants and survival, development, and reproduction of other aquatic organisms（タニシと温度がイネの生育と水田の湛水生物の生存、発育、繁殖に与える影響）
学位審査委員	主査 山形大学教授 安田 弘法 副査 佐藤 智（山形 准教授）、小池 正徳（帯広 教授）、 安 嬰（岩手 講師）

論文の内容の要旨

The aim of this study was to understand the mechanism of how the mud snail and temperature affect the survival, development, and reproduction of other aquatic organisms and performance of rice plant in a paddy field. In order to understand these effects, two experiments were carried out at outside and in the laboratory. Firstly, the effects of ambient temperature and the mud snail on rice plant performance were examined in 2015 using a factorial experiment. The presence of mud snails resulted in significantly increased plant height and SPAD value (reflecting leaf color) of the rice plants, although the tiller number was not significantly affected. The effects of temperature (high versus normal) on rice plant performance were assessed by the experiments inside and outside greenhouse. The results suggested that the effects of temperature differed among plant performances; plants grew taller but had fewer tillers when the rice was grown at high temperature, while SPAD was not significantly affected. Significantly more roots appeared on the soil surface when snails were present. In general, the mud snails resulted less excreta at high temperature than at normal temperature. The results of this study indicated that ambient temperature influenced rice plant performance both directly, and indirectly through the activity of the mud snails.

Secondly, in order to understand the effects of temperature and mud snails on the survival, development, and reproduction of other aquatic organisms aquatic organisms at individual, population, and community level, laboratory experiments were conducted. The aim of this study was (1) to reveal the effects of temperature and the mud snails on the biotic parameters mentioned above of aquatic organisms at individual,

population, and community level, and (2) to understand the possible mechanism influencing biotic and abiotic interactions. Other aquatic organisms except the mud snails used for the experiments were sakamakigai and kawanina. To clarify the effects of temperature and mud snails, biotic and abiotic parameters were measured in the experimental containers.

In general, temperature did not affect biotic factors such as the survival, development, and reproduction of other aquatic organisms, while it influenced on abiotic factors at individual, population, and community experiments. On the other hand, the effects of snails differed from the temperature effects; the snails gave much influence on the biotic factors than abiotic ones. The similarity of the effects of temperature at individual, population, and community experiments was found in dissolved oxygen, pH, egg clutches of sakamakigai, and juveniles of mud snails. It was suggested that the effects of temperature on those parameters were not affected by increased number of species and individuals. The difference in the effects of temperatures in individual, population, and community experiments was found in the organic matters, chlorophyll content, and potassium. In addition, the effects of temperatures on those parameters were affected by increased number of species and individuals. In terms of the effects of mud snails, the similarity was found in body weight of kawanina, organic matters, egg clutches of sakamakigai, and juveniles of kawanina suggesting that the effects of mud snails on those parameters were not affected by increased number of species and individuals. The difference was found in the survival of kawanina, body weight of sakamakigai, and nitrate, suggesting that the effects of mud snails on those parameters were affected by increased number of species and individuals. In general, the sum of positive effects of both temperatures and mud snails on community level seemed to be higher than on either individual or population levels. This was probably because the number of interactions among organisms affected by the number of both species and individuals was getting higher along the gradient of the experimental level. In addition, this study clearly showed that in the community level mud snails significantly affected the performance of sakamakigai by increasing the survival, bodyweight, and number of its egg clutches. The enhanced organic matters and concentration of nitrate in the water was also affected by mud snails and possibly supporting the performances of sakamakigai. Furthermore, decreased survival of kawanina, as affected by mud snails, in turn probably increased the performances of sakamakigai by reducing the competition.

This study suggested that one of possible mechanisms how mud snails positively influenced the community structure of aquatic organisms previously studied i.e mud snails provide suitable environment through supplying nutrients which are advantageous to the performance of other aquatic organisms e.g. sakamakigai.

論文審査の結果の要旨

地球温暖化は、作物の栽培適地や生育に影響を及ぼすだけでなく農業生態系の生物の発育、生存、繁殖や種間相互作用にも影響を及ぼす。また、化学肥料や農薬が及ぼす農業生態系への多面的な負の影響を回避するために、最近では化学肥料や農薬等を使用しない「自然共生型」での農業も注目されている。

本論文では、このような農業をめぐる多面的な背景を考慮し、水田の生物由来の養分を供給する可能性があるタニシを材料に、タニシと温度の変化が、イネの生育と水田の淡水生物の生存、発育、繁殖に及ぼす影響をミニ水田と室内実験を通じ、個体、個体群、群集の3つのレベルで明らかにした。

その結果、まず、ミニ水田での実験（温室と野外）による、温度とタニシがイネの生育に与える影響では、タニシは草丈と葉色を有意に増加させたが、株数は非有意であった。高温により草丈が高くなったが、株数は少なく、葉色への影響は非有意であった。タニシがいると、地表部の根の数が有意に多くなった。また、タニシの糞は、高温だと少なくなり、これは高温での摂食活動の低下に起因すると考えられた。

一方、タニシと温度（23度と29度）がサカマキガイとカワニナの生存、発育、繁殖等の生物的要因と窒素、カリウム、葉緑体、有機物、溶存酸素、pH等の非生物的要因に与える影響を解明する群集レベルの室内実験では、温度は非生物的要因に与える影響が強く、タニシは生物的要因に与える影響が強い傾向があった。特に、タニシはサカマキガイの産卵数を増加させたが、カワニナへの影響はなかった。一方、タニシは、サカマキガイ及びカワニナと共存することで繁殖が増加した。さらにタニシは、有機物や窒素を増加させ、温度の増加は、有機物、窒素、カリウムを増加させた。

タニシがいる水田では、湛水生物の多様性が高く、イネの生育が促進されとの報告がある。本研究では、タニシがいると湛水生物相互の繁殖が増加し、それが水田の多様性増加や生物由来の養分の増加によるイネの生育促進につながることを明らかにした。さらに、高温（29度）は、湛水生物の活動を高め生物由来の養分が多くなり、イネの生育を促進する可能性も示唆された。

これらは、タニシが、湛水部生物の個体数を増加させる機構の解明と、生物の活動に好適な温度では生物由来の養分が増加し、イネの生育が促進されるボトムアップ効果があることを示した新知見である。また、このような淡水生物の活用は「自然共生型」水稻栽培の基礎資料としても極めて価値が高いと思われる。それゆえ、本審査委員会は、「岩手大学大学院連合農学研究科博士学位論文審査基準」に則り審査した結果、本論文を博士（農学）の学位論文として十分価値があるものと認めた。

学位論文の基礎となる学術論文

1. Kurniawan, A.H., S. Sato, and H. Yasuda (2018)
Effects of ambient temperature and the mud snail *Cipangopaludina chinensis laeta* (Architaenioglossa: Viviparidae) on performance of rice plants. *Applied Entomology and Zoology*, Vol 53 (1), 137-141.