UNIVERSITI PUTRA MALAYSIA

ECOBIOLOGICAL ASPECTS OF INVASIVE APPLE SNAILS (Pomacea spp.) IN RICE FIELDS, PENINSULAR MALAYSIA

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By

GILAL ARFAN AHMED

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

June 2015

DEDICATION

My Paradise

My Mother

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

ECOBIOLOGICAL ASPECTS OF INVASIVE APPLE SNAILS (*Pomacea* spp.) IN RICE FILEDS, PENINSULAR MALAYSIA

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June 2015

Chair: Professor Rita Muhamad Awang, PhD
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Alien invasive apple snails, *Pomacea canaliculata* Lamarck and *Pomacea maculata* Perry were introduced into Malaysia around 1991. Since their introduction, *Pomacea* spp. have damaged vast area under rice cultivation and are major threat to rice self sufficiency in Malaysia. However, no thorough research has been done on their ecobiological aspects in the country, especially in Peninsular Malaysia. Therefore, this study focused on understanding the different ecobiological aspects of these apple snails. Studies on the abundance of *Pomacea* spp. in twenty five rice fields of five states in Peninsular Malaysia, confirmed the presence of *P. maculata* and *P. canaliculata. Pomacea maculata* was more abundant and widely distributed. Population of *P. canaliculata* was not recorded in Penang. Rice fields in Perak showed the highest population of snails (10.13 snails / m^2). The lowest population was recorded from rice fields of Kelantan and Kedah during sowing and harvesting, respectively. Population of snails was significantly higher during sowing of rice as compared to harvesting due to the presence of plenty of water and young rice seedlings as their food. Population fluctuation of egg, juvenile and adult snails in a rice field over two rice growing seasons from August, 2013 to May, 2014 highlighted comparatively higher populations during off season in comparison to main season. Population of different stages of *P. maculata* increased during reproductive and ripening stages of rice. No population of juveniles, females and males was recorded at harvesting due to water drain out from rice field. Higher populations were significantly correlated to relative humidity, rainfall, and density of *Limnocharis flava* and *Ischaemum rugosum*. Different indices of population dispersion i.e., variance to mean ratio, Lloyd index and Green Co-efficient mostly confirmed regular or uniform dispersion pattern of various stages of *P. maculata*. However, Iwao's patchiness regression and Taylor's power law mostly confirmed aggregated dispersion pattern. Findings of the growth studies confirmed that size of one day hatchlings of *P. canaliculata* was significantly higher than *P. maculata.* Comparatively higher growth rate was observed in *P. canaliculata* than *P. maculata* with both species sexually matured during 27th and 32nd weeks, respectively. No significant difference was observed in shell length, height and width of the two species at maturity. Both *Pomacea* spp. started consuming rice during 4th week after hatching from eggs. Mating and oviposition behavior studies confirmed higher mating frequency, oviposition duration and higher number of eggs per clutch of smaller size along with more eggs per minute in *P. maculata.* Mating and oviposition in both species occurred mostly during

the night hours. No difference was recorded for mating duration, oviposition frequency, hatching success and hatching period between two species. Highly significant correlation between oviposition duration and total number of eggs was only observed in *P. canaliculata*. Feeding preference of 1, 2 and 3 cm sized snails of the two species on leaves and stems of rice and *L. flava* confirmed higher preference for *L. flava* in all three sizes based on higher consumption. *Limnocharis flava* also supported higher growth and weight gain in both *Pomacea* spp. Rice stems supported the least growth and weight gain. Study on damage potential of two *Pomacea* spp. to rice established by direct seeding and 14, 21 and 28 days old transplanted seedlings showed that both species caused 100% loss to direct seeded and 14 days transplanted rice. Damage decreased with older transplanted seedlings with the least damage recorded in 28 days old transplanted rice. No loss of seedlings by two *Pomacea* spp. was recorded in 21 and 28 days old transplanted rice after 5^{th} and 4^{th} weeks, respectively. Sowing methods and damage by *Pomacea* spp. caused considerable reduction in number of tillers, panicles and Leaf Area Index. Higher number of these parameters was recorded in 21 days old transplanted rice control treatment. Additional space in 28 days old transplanted rice snail infested plots due to missing seedlings compensated them by producing more spikelets per panicle, grain filling percentage and grain harvest index. Accordingly, yields in 28 days old transplanted rice treatments damaged by *Pomacea* spp. were comparable with control treatments of 28 and 21 days old transplanted rice. Studies on the effect of water levels of 5 and 2 cm, and densities of 1, 2 and 3 snails per plot of *Pomacea* spp. confirmed significantly higher damage by all the snail densities at 5 cm water level. Higher damage was recorded at a density of 3 snails / plot of either species. No significant difference between *P. maculata* and *P. canaliculata* was recorded in rice grown by different methods at two water levels, suggesting the same damage potential of the two species to rice.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

ASPEK EKOBIOLOGI SIPUT GONDANG INVASIF (*Pomacea* spp.) DI SAWAH PADI, SEMENANJUNG MALAYSIA

Oleh

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Spesis invasif asing, *Pomacea canaliculata* Lamarck dan *Pomacea maculata* Perry telah diperkenalkan di Malaysia sekitar tahun 1991. Sejak diperkenalkan, *Pomacea* spp. telah menyebabkan kerugian yang besar pada kebanyakan kawasan penanaman padi dan menjadi ancaman kepada sistem sara diri di Malaysia. Akan tetapi, sehingga kini, masih tiada kajian mendalam dijalankan tentang aspek ekobiologi siput gondang terutama di Semenanjung Malaysia. Oleh itu, kajian tentang aspek ekobiologikal berbeza telah dijalankan. Kajian mengenai taburan *Pomacea* spp. di 25 kawasan sawah padi yang berbeza pada lima negeri di Semenanjung Malaysia mengesahkan kehadiran dua spesis siput gondang yang telah dikenal pasti iaitu *P. maculata* dan *P. canaliculata*. Populasi *Pomacea maculata* mempunyai taburan yang luas dan banyak. Populasi *P. canaliculata* tidak diperoleh di Pulau Pinang. Sawah padi di Perak telah merekodkan populasi tertinggi siput gondang iaitu 10.13 siput / m^2. Populasi siput gondang yang terendah telah dicatatkan di Kelantan dan Kedah semasa menyemai dan menuai hasil, masing-masing. Populasi siput gondang adalah lebih tinggi ketika menyemai berbanding semasa menuai disebabkan oleh faktor air yang lebih banyak dan umur padi yang muda yang menjadi makanan utama siput gondang. Kajian turun naik populasi siput gondang pada setiap peringkat; telur, juvana, siput betina dan jantan di sawah padi pada dua musim penanaman iaitu musim utama dan musim luar dari Ogos, 2013 sehingga Mei, 2014 menunjukkan perbandingan populasi yang lebih tinggi semasa musim luar berbanding semasa musim utama. Peningkatan populasi *P. maculata* bagi setiap peringkat yang berbeza telah diperhatikan ketika peringkat pembiakan dan matang. Tiada populasi juvana, siput jantan dan betina direkodkan ketika peringkat penuaian disebabkan oleh pengaliran keluar air dari sawah. Bagi faktor-faktor alam sekitar pula, populasi siput yang tinggi mempunyai hubungan korelasi yang signifikan dengan kelembapan, taburan hujan dan kepadatan *Limnocharis flava* dan *Ischaemum rugosum*. Indeks perbezaan bagi serakan populasi sebagai contoh varians kepada nisbah min, 'Lloyd index' dan 'Green Co-efficient' mengesahkan corak serakan tetap atau seragam pada setiap peringkat *Pomacea* spp. Bagaimanapun, teori regresi Iwao dan teori undang-undang kuasa Taylor kebanyakkanya mengesahkan corak serakan agregat. Hasil kajian pertumbuhan menunjukkan saiz bagi anak tetas yang berumur sehari bagi *P. canaliculata* adalah lebih cepat berbanding *P. maculata.* Secara perbandingannya, kadar pertumbuhan adalah lebih tinggi pada *P. canaliculata* berbanding *P. maculata* walaupun kedua-dua spesis matang dari segi seksual masing-masing pada minggu ke 27 dan 32. Akan tetapi, tiada

perbezaan ketara diperhatikan pada panjang, tinggi dan lebar cangkerang bagi kedua-dua spesis. *Pomacea* spp. mula memakan padi apabila mencecah umur empat minggu selepas tetas. Kajian tentang tingkah laku ketika mengawan dan oviposit mengesahkan bahawa semakin bertambah kekerapan mengawan, tempoh oviposit dan bilangan telur per kelompok lebih tinggi dan lebih telur dihasilkan dalam seminit bagi *P. maculata* berbanding *P. canaliculata.* Proses mengawan dan oviposit telur bagi kedua-dua spesis berlaku pada waktu malam dan tiada perbezaan dicatatkan bagi tempoh mengawan, kekerapan oviposit, kejayaan penetasan dan juga tempoh penetasan. Korelasi yang amat ketara antara tempoh oviposit dan jumlah bilangan telur telah diperhatikan pada *P. canaliculata*. Keutamaan pemakanan bagi siput berukuran 1, 2 dan 3 cm *P. maculata* dan *P. canaliculata* antara daun dan batang padi dan juga *L. flava* menunjukkan ketiga-tiga siput berlainan saiz itu lebih menggemari *L. flava*. *Limnocharis flava* juga membantu dalam meningkatkan pertumbuhan dan pertambahan berat pada *Pomacea* spp. manakala batang padi kurang menyumbang kepada pertumbuhan dan pertambahan berat siput. Kajian pada potensi kerosakan kedua-dua *Pomacea* spp. antara padi bagi kaedah penanaman terus dan anak padi berumur 14, 21 dan 28 hari selepas pemindahan menunjukkan bahawa kedua-dua spesis menyebabkan 100% kerosakan pada padi yang ditanam terus dan anak padi berumur 14 hari selepas dipindahkan. Bagaimanapun, kerosakan semakin berkurang apabila umur anak padi yang lebih tua digunakan dan anak padi berumur 28 hari menunjukkan tahap kerosakan paling rendah. Tiada kerugian disebabkan oleh *Pomacea* spp. dicatatkan bagi anak padi berumur 21 dan 28 hari selepas minggu kelima dan keempat. Kaedah semaian dan kerosakan oleh kedua-dua *Pomacea* spp. mengakibatkan pengurangan yang ketara pada bilangan anak padi, bilangan tangkai dan juga indeks keluasan daun bagi anak padi berumur 21 hari selepas dipindahkan berbanding kawalan. Jarak penanaman yang betul beserta ruang tambahan yang disebabkan oleh serangan siput gondang membolehkan anak padi berumur 28 hari untuk menghasilkan lebih spikelet pada setiap tangkai, peratusan bijirin dan indeks tuaian bijirin. Sewajarnya, hasil bagi rawatan anak pokok berumur 28 hari adalah setanding rawatan kawalan 28 dan 21 hari. Kajian tentang pengaruh paras air; 5 cm dan 2 cm terhadap kepadatan satu, dua dan tiga ekor siput bagi setiap plot dan setiap spesis Pomacea mengesahkan bahawa jumlah kerosakan yang lebih tinggi adalah pada paras air 5 cm berbanding 2 cm. Tahap kerosakan yang tinggi telah direkodkan pada plot yang berkepadatan tiga ekor siput berbanding yang lain. Tiada perbezaan yang ketara antara *P. maculata* dan *P. canaliculata* yang telah direkodkan pada kawasan penanaman padi dengan kaedah yang berbeza dan paras air yang berbeza kerana kedua- dua spesis mempunyai potensi kerosakan yang sama.

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I certify that a Thesis Examination Committee has met on 19 June 2015 to conduct the final examination of Gilal Arfan Ahmed on his thesis entitled "Ecobiological Aspects of Invasive Apple Snails (*Pomacea* spp.) in Rice Fields, Peninsular Malaysia" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosphy. The members of the Supervisory Committee were as follows:

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CHAPTER 1

INTRODUCTION

The growing world population that is expected to reach 9 billion by 2050 will necessitate increased production and supply of food crops to support their lives (Nelson *et al.,* 2010; Tscharntke *et al.,* 2012). Accordingly, rice, *Oryza sativa* L. holds the key importance as it is the most important staple food and source of livelihood for more than a billion population of the globe (Pandey *et al.,* 2012; Tobias, 2012). Moreover, after the food crisis of 2007-2008, the importance of rice has increased as a strategic food crop. Accordingly, many countries have changed their policies for attaining the 100% food self sufficiency, where rice holds a key position (Dawe, 2012).

In Malaysia, rice is mostly grown under flooded conditions in eight granary areas of Peninsular Malaysia, Sabah and Sarawak (Akinbile *et al.,* 2011). Malaysia is ranked 24th in terms of rice production in the world with annual production of 2.627 million tons (FAO, 2014). Total area under rice cultivation in Malaysia in 2013 was 688,207 hectares, out of which 43,118 hectares were situated in Sabah and 124,241 in Sarawak (DOA, 2014). Presently, Muda Agricultural Development Authority (MADA) and Kemudu Agriculture Development Authority (KADA) are the two main rice growing areas in Malaysia.

Currently, rice production in Malaysia is insufficient for the food requirements of the local population that has increased tremendously during 1990-2007. Accordingly, the demand for rice has increased from 1.5 million tons to 2.3 million tons in the same period (Vengedasalam *et al.,* 2011). Furthermore, during the 2008 global financial crises, Malaysia found it hard to fulfill its rice demand due to high import cost of rice. Considering the same, Malaysian government started initiatives to make the country 100% self-sufficient by 2015 in 9th Malaysian Plan (2006-2010). Despite the government's efforts that includes an allocation of the additional rice area in Sabah, Sarawak and Pahang, rehabilitation of land under rice cultivation, improvement of agriculture infrastructure and development of high yielding and early maturing rice varieties; the country failed to achieve the target. Presently, the country is 73% self sufficient in terms of rice demand, while the remaining is imported from different countries (Akinbbile *et al.,* 2011).

There are many factors affecting the rice production in the country. Reduction or no increase in the area under rice cultivation due to urbanization and cultivation of more economical crops and reduction of labor force especially youths affected the rice productivity. Increase in rice yield from 2.1 tons / ha in 1960 to 3.6 tons / ha in 2008, is the only factor that contributed towards the country's increased rice production. Moreover, pests remained the major threat to the rice productivity, reducing its both quantity and quality (Wong *et al.,* 2010; Akinbbile *et al.,* 2011).

Rice is attacked by a number of pests including weeds, pathogens, arthropods, rodents and birds (Jahn *et al.,* 2005). Recently, apple snails, *Pomacea* spp. belonging to genus *Pomacea* (Mollusca: Ampullariidae) are posing great threat to rice productivity in many countries of the world, including Malaysia (Halwart, 1994a; Rawlings *et al.,* 2007; Hayes *et al.,* 2008).

Apple snails, *Pomacea* spp. were first found in Peninsular Malaysia in 1991and were identified as *Pomacea canaliculata* and *Pomacea maculata* (Teo, 2005; Yahaya *et al.,* 2006). These snail species are native to South America and were introduced to many countries of the world, including Southeast Asia for aquariums and food trade. However, snails failed to achieve the intended uses, discarded in the wild and established as major pests of many macrophytes including rice (Rawlings *et al.,* 2007; Hayes *et al.,* 2008; Horgan *et al.,* 2012). Considering their invasive attributes, i.e., high breeding potential and survival under various harsh environments, one of the species, *P. canaliculata* was included in the World's worst 100 invasive species (Lowe *et al.,* 2000).

Now, these pomacean snails are present in all granary areas of Peninsular Malaysia and Sabah and Sarawak. Since 1991, these snails have attacked more than 17,000 ha of rice area in the Peninsular Malaysia. The snails caused heavy losses during the early growth of rice, especially in direct seeded rice. Often, severe infestation of the snails can cause complete loss of rice crop in the field. In Malaysia, these snails are more devastating than other countries because of large scale direct seeding and flooded conditions in rice fields either because of irrigation water or heavy rains (Yahaya *et al.,* 2006). The estimated losses due to attack of *Pomacea* spp. were approximately RM82.5Million in 2009 (DOA, 2014).

When infestation of freshwater apple snails (*Pomacea* spp.) to rice increased continuously, no serious research has been done on their ecology, biology or damage potential in Peninsular Malaysia. Therefore, considering the economic and ecological importance of the apple snails to rice; the staple food of Malaysia, it has become imperative to plan some basic studies on their ecobiological aspects. This study focused on the identification and distribution of different apple snail species in the main rice growing areas of Peninsular Malaysia along with their feeding, growth and damage potential to rice. Accordingly, this research study was conducted with the following objectives:

1. To study the distribution of apple snails in rice fields of Peninsular Malaysia
2. To study the population fluctuation of apple snails in a rice field
3. To study the comparative growth, mating and oviposition of apple snails
4. To investigate feeding preference of apple snails on rice and yellow bur-head
5. To evaluate damage potential of apple snails to rice

It is expected that the results of this study will contribute towards better understanding of the basic aspects of apple snail's behavior and damage potential to rice. Information obtained can be utilized for their proper management by integrating different control measures. Such efforts will further result in the better and improved rice productivity in Malaysia, a step towards the self-sufficiency in rice productivity.

REFERENCES

Acosta, B. O. and Pullin, R. S. (Eds.). (1991). Environmental impact of the golden snail (*Pomacea* sp.) on rice farming systems in the Philippines: *Summary Report of the Workshop Held at the Freshwater Aquaculture Center,* Central Luzon State University, 9-10 November 1989, Nueva Ecija, Philippines.

Akinbile, C., El-Latif, K. M. A., Abdullah, R. and Yusoff, M. (2011). Rice production and water use efficiency for self-sufficiency in Malaysia: A review. *Trends in Applied Sciences Research,* 6(10): 1127-1140.

Albrecht, E. A., Carreno, N. B. and Castro-Vazquez, A. (1996). A quantitative study of copulation and spawning in the South American apple-snail, *Pomacea canaliculata* (Prosobranchia: Ampullariidae). *Veliger,* 39(2): 142-147.

Albrecht, E., Carreno, N. and Castro-Vazquez, A. (1999). A quantitative study of environmental factors influencing the seasonal onset of reproductive behaviour in the South American apple-snail *Pomacea canaliculata* (Gastropoda: Ampullariidae). *Journal of Molluscan Studies,* 65(2): 241-250.

Albrecht, E. A., Koch, E., Carreño, N. B. and Castro-Vazquez, A. (2005). Control of the seasonal arrest of copulation and spawning in the apple snail *Pomacea canaliculata* (Prosobranchia: Ampullariidae): differential effects of food availability, water temperature, and day length. *Veliger,* 47(3): 169-174.

Anderson, B. (1993). The Philippines snail disaster. *The Ecologist,* 23: 70-72.

Awan, T., Ahmad, M., Ashraf, M. and Ali, I. (2011). Effect of different transplanting methods on paddy yield and its components at farmer's field in rice zone of Punjab. *The Journal of Animal and Plant Sciences,* 21(3): 498-502.

Baloch, W. A., Memon, U. N., Burdi, G. H., Soomro, A. N., Tunio, G. R.A. and Khatian, A. A. (2012). Invasion of channeled apple snail *Pomacea canaliculata*, Lamarck (Gastropoda: Ampullariidae) in Haleji Lake, Pakistan. *Sindh University Research Journal (Science Series)*, 44: 263-266.

Baker, P., Zimmanck, F. and Baker, S. M. (2010). Feeding rates of an introduced freshwater gastropod *Pomacea insularum* on native and non indigenous aquatic plants in Florida. *Journal of Molluscan Studies,* 76(2), 138-143. doi: 10.1093/mollus/eyp050.

Barnes, M. A., Fordham, R. K., Burks, R. L. and Hand, J. J. (2008). Fecundity of the exotic apple snail, *Pomacea insularum*. *Journal of the North American Benthological Society*, 27(3): 738-745.

Basilio, R. (1991). Problems of golden snail infestation in rice farming. In: *Proceedings of the Workshop on Environmental Impact of the Golden Snail (Pomacea sp.) on Rice Farming Systems in the Philippines.* Nueva Ecija (Philippines). pp. 11-12.

Birhane, A. (2013). Effect of planting methods on yield and yield components of rice (*Oryza sativa* L.) varieties in Tahtay Koraro Wereda, Northern Ethiopia. *International Journal of Technology Enhancements and Emerging Engineering Research*, 1(5): 1-5.

Boland, B. B., Meerhoff, M., Fosalba, C., Mazzeo, N., Barnes, M. A. and Burks, R. L. (2008). Juvenile snails, adult appetites: contrasting resource consumption between two species of apple snails (*Pomacea*). *Journal of Molluscan Studies*, 74(1): 47-54.

Bouman, B. A. M., Humphreys, E., Tuong, T. P. and Barker, R. (2006). Rice and water. *Advance Agronomy*, 92:187-237.

Bouman, B. A. M., Lampayan, R. M. and Tuong, T. P. (2007). W*ater management in rice*: *coping with water scarcity*. International Rice Research Institute, Los Baños, Philippines. pp. 54.

Buendia, L.M. (1988). The golden apple snail: A rice menace. *Monitor, Manila* 16(2): 6.

Burela, S. and Martín, P. R. (2011). Evolutionary and functional significance of lengthy copulations in a promiscuous apple snail, *Pomacea canaliculata* (Caenogastropoda: Ampullariidae). *Journal of Molluscan Studies*, 77(1): 54-64.

Burks, R. L., Kyle, C. H. and Trawick, M. K. (2010). Pink eggs and snails: field oviposition patterns of an invasive snail, *Pomacea insularum*, indicate a preference for an invasive macrophyte. *Hydrobiologia*, 646(1): 243-251.

Burks, R. L., Hensley, S. A. and Kyle, C. H. (2011). Quite the appetite: juvenile island apple snails (*Pomacea insularum*) survive consuming only exotic invasive plants. *Journal of Molluscan Studies*, 77(4): 423-428. doi: http://dx.doi.org/10.1093/mollus/eyr022.

Burlakova, L. E., Karatayev, A. Y., Padilla, D. K., Cartwright, L. D. and Hollas, D. N. (2009). Wetland restoration and invasive species: apple snail (*Pomacea insularum*) feeding on native and invasive aquatic plants. *Restoration Ecology*, 17(3): 433-440. doi: 10.1111/j.1526-100X.2008.00429.x.

Burlakova, L. E., Padilla, D. K., Karatayev, A. Y., Hollas, D. N., Cartwright, L. D. and Nichol, K. D. (2010). Differences in population dynamics and potential impacts of a freshwater invader driven by temporal habitat stability. *Biological Invasions*, 12(4): 927-941.

Byers, J. E., Reichard, S., Randall, J. M., Parker, I. M., Smith, C. S., Lonsdale, W. M. ..... and Hayes, D. (2002). Directing research to reduce the impacts of non indigenous species. *Conservation Biology*, 16: 630–640.

Byers, J. E., McDowell, W. G., Dodd, S. R., Haynie, R. S., Pintor, L. M. and Wilde, S. B. (2013). Climate and pH predict the potential range of the invasive apple snail (*Pomacea insularum*) in the Southeastern United States. *PLoS ONE*. 8(2).

Cantanhede, S. P. D., Fernandez, M. A., Mattos, A. C. D., Montresor, L. C., Silva-Souza, N. and Thiengo, S. C. (2014). Freshwater gastropods of the Baixada Maranhense Microregion, an endemic area for schistosomiasis in the State of Maranhão, Brazil: I - qualitative study. *Revista da Sociedade Brasileira de Medicina Tropical*, 47: 79-85.

Carlsson, N. O. L. (2006). Invasive golden apple snails are threatening natural ecosystems in Southeast Asia. In: Joshi, R.C., Sebastian, L.S. (Eds.), *Global Advances in Ecology and Management of Golden Apple Snails*. Philippine Rice Research Institute, Nueva Ecija. pp. 61-72.

Carlsson, N. O. L., Brönmark, C. and Hansson, L. A. (2004). Invading herbivory: the golden apple snail alters ecosystem functioning in Asian wetlands. *Ecology*, 85(6): 1575-1580.

Carlsson, N. O. and Lacoursiere, J. O. (2005). Herbivory on aquatic vascular plants by the introduced golden apple snail (*Pomacea canaliculata*) in Lao PDR. *Biological Invasions*, 7(2): 233-241.

Carlsson, N. O. L. and Brönmark, C. (2006). Size-dependent effects of an invasive herbivorous snail (*Pomacea canaliculata*) on macrophytes and periphyton in Asian wetlands. *Freshwater Biology*, 51(4): 695-704.

Carlton, J. T., Ruiz, G. M., Mooney, H., Mack, R., McNeely, J., Neville, L., . . . and Waage, J. (2005). Vector science and integrated vector management in bioinvasion ecology: conceptual frameworks. In: H. A. Mooney (Ed.), *Invasive Alien Species: A New Synthesis*. Island Press, Washington.

Carpenter, S. R., Stanley, E. H. and Vander Zanden, M. J. (2011). State of the world's freshwater ecosystems: physical, chemical, and biological changes. *Annual Review of Environment and Resources*, 36: 75-99.

Catalán, N., Fernández, S. and Winik, B. (2002). Oviductal structure and provision of egg envelops in the apple snail *Pomacea canaliculata* (Gastropoda, Prosobranchia, Ampullariidae). *Biocell*, 26(1): 91.

Caton, B. P., Mortimer, M., Hill, J. E. and Johnson, D. E. (2010). *A practical field guide to weeds of rice in Asia*. International Rice Research Institute, Los Baños, Laguna, Philippines. pp. 118.

Cazzaniga, N. J. (2002). Old species and new concepts in the taxonomy of *Pomacea* (Gastropoda: Ampullariidae). *Biocell*, 26(1): 71-81.

Cazzaniga, N. J. (2006). *Pomacea canaliculata*: harmless and useless in its natural realm (Argentina). In: Joshi, R.C., Sebastian, L.S. (Eds.), *Global Advances in Ecology and Management of Golden Apple Snails*. Philippine Rice Research Institute, Nueva Ecija. pp. 37-60.

Chaichana, R. and Sumpan, T. (2014). The potential ecological impact of the exotic snail *Pomacea canaliculata* on the Thai native snail *Pila scutata*. *Science Asia*, 40(1): 11-15.

Conner, S., Pomory, C. and Darby, P. (2008). Density effects of native and exotic snails on growth in juvenile apple snails *Pomacea paludosa* (Gastropoda: Ampullariidae): a laboratory experiment. *Journal of Molluscan Studies*, 74(4): 355-362.

Cowie, R. H. (2001). Can snails ever be effective and safe biocontrol agents? *International Journal of Pest Management*, 47(1): 23-40.

Cowie, R. H. (2002). 5 Apple Snails (Ampullariidae) as Agricultural Pests: their Biology, Impacts and Management. In: G. M. Barker (Ed.), *Molluscs as Crop Pests*. CABI, Wallingford. pp. 145-192.

Cowie, R. H. (2013). Pathways for transmission of angiostrongyliasis and the risk of disease associated with them. *Hawai'i Journal of Medicine and Public Health*, 72(6 Suppl 2): 70.

Cowie, R. H. and Hayes, K. A. (2012). Apple snails. In: Francis, R. A. (Ed.), *A handbook of global freshwater invasive species.* Earthscan, London. pp. 207-217.

Cowie, R. H. and Thiengo, S. C. (2003). The apple snails of the Americas (Mollusca: Gastropoda: Ampullariidae: Asolene, Felipponea, Marisa, Pomacea, Pomella): A nomenclatural and type catalog. *Malacologia*, 45(1): 41-100.

Cowie, R. H., Hayes, K. A., Thiengo, S. C., Joshi, R. and Sebastian, L. (2006). What are apple snails? Confused taxonomy and some preliminary resolution. In: Joshi, R.C., Sebastian, L.S. (Eds.), *Global Advances in Ecology and Management of Golden Apple Snails*. Philippine Rice Research Institute, Nueva Ecija. pp. 3-23.

Cowie, R. H., Dillon Jr, R. T., Robinson, D. G. and Smith, J. W. (2009). Alien non-marine snails and slugs of priority quarantine importance in the United States: A preliminary risk assessment. *American Malacological Bulletin*, 27(1/2): 113-132.

Cruz, R. (1987). Golden snail infest rice and corn fields in six towns. *Manila Jounral*, 4: 4.

Dai, L., Wang, W., Dong, X., Hu, R. and Nan, X. (2011). Molluscicidal activity of cardiac glycosides from *Nerium indicum* against *Pomacea canaliculata* and its implications for the mechanisms of toxicity. *Environmental Toxicology and Pharmacology*, 32(2): 226-232.

Dapar, M. L. G., Garcia, S. M. G., Achacoso, M. V. D., Debalucos, C. A. P., Moneva, C. S. and Demayo, C. G. (2014). Describing populations of *Pomacea canaliculata* Lamarck from selected areas in Mindanao, Philippines using

Relative warp analysis of the whorl shell shape. *Australian Journal of Basic and Applied Science*, 8(5): 355-360.

Darby, P. C., Bennetts, R. E. and Percival, H. F. (2008). Dry down impacts on apple snail (*Pomacea paludosa*) demography: implications for wetland water management. *Wetlands*, 28(1): 204-214. doi: 10.1672/07-115.1.

Dawe, D. (2012). *The Rice Crisis: "Markets, Policies and Food Security"*. Food and Agriculture Organization of United nations and Earthscan, London, UK. pp. 368.

Dawe, D., Pandey, S. and Nelson, A. (2010). Emerging trends and spatial patterns of rice production. In: Pandey, S., Byerlee, D., Dawe, D., Dobermann, A., Mohanty, S., Rozelle, S. and Hardy, B. (Eds.), *Rice in the Global Economy: Strategic Research and Policy Issues for Food Security*. International Rice Research Institute (IRRI), Los Baños, Philippines. pp. 15-35.

De Datta, S. K. (1981). *Principles and practices of rice production*: International Rice Research Institute (IRRI), Los Baños, Philippines. pp. 643.

dela Cruz M. S., R. C. Joshi, E. R. Tiongco and A. V. Antonio. (2001). Management options for the golden apple snail. *Rice Technology Bulletin No. 33*. Department of Agriculture, Philippine Rice Research Institute (PhilRice), Philippines. pp 12.

Dillon Jr, R. T. (2006). Freshwater gastropoda. In: Sturm, C. F., Pearce, T. A. and Valdés, Á. (Eds.), *The mollusks: A guide to their study, collection, and preservation.* The American Malacological Society, Pittsburgh, PA, USA. pp. 251-259.

Diupotex-Chong, M. E., Cazzaniga, N. J., Hernández-Santoyo, A. and Betancourt-Rule, J. M. (2004). Karyotype description of *Pomacea patula catemacensis* (Caenogastropoda, Ampullariidae), with an assessment of the taxonomic status of *Pomacea patula*. *Biocell*, 28(3): 279-285.

DOA (2014). Paddy statistics of Malaysia. Department of Agriculture, Malaysia. www.doa.gov.my. Accessed on December 12, 2014.

Dong, S., Zheng, G., Yu, X. and Fu, C. (2012). Biological control of golden apple snail, *Pomacea canaliculata* by Chinese soft-shelled turtle, *Pelodiscus sinensis* in the wild rice, *Zizania latifolia* field. *Scientia Agricola*, 69(2): 142-146. doi: http://dx.doi.org/10.1590/S0103-90162012000200009.

Donnay, T. J. and Beissinger, S. R. (1993). Apple snail (*Pomacea solioides*) and freshwater crab (*Dilocarcinus dentatus*) population fluctuation in the Ilanos of Venezuela. *Biotropica*, 25: 206-214.

Dreijers, E., Reise, H. and Hutchinson, J. M. C. (2013). Mating of the slugs *Arion lusitanicus* auct. non Mabille and *A. rufus* (L.): Different genitalia and mating behaviours are incomplete barriers to interspecific sperm exchange. *Journal of Molluscan Studies*, 79(1): 51-63.

EFSA (2012). Scientific opinion on the evaluation of the pest risk analysis on *Pomacea insularum*, the island apple snail, prepared by the Spanish Ministry of Environment and Rural and Marine Affairs. *European Food Safety Authority Journal*, 10(1): 2552 [57 pp.]. doi:10.2903/j.efsa.2012.2552. Available online: www.efsa.europa.eu/efsajournal.

Estebenet, A. L. and Cazzaniga, N. J. (1992). Growth and demography of *Pomacea canaliculata* (Gastropoda: Ampullariidae) under laboratory conditions. *Malacological Review*, 25(1-2): 1-12

Estebenet, A. L. and Cazzaniga, N. J. (1998). Sex-related differential growth in *Pomacea canaliculata* (Gastropoda: Ampullariidae). *Journal of Molluscan Studies*, 64(1): 119-123.

Estebenet, A. L. and Martín, P. R. (2000). Inter- and intra-population variation in growth patterns of *Pomacea canaliculata* (Gastropoda: Ampullariidae). *Proccedings of International Congress of Medical and Applied Malacology 4.* Havana, Cuba.

Estebenet, A. L. and Martín, P. R. (2002). *Pomacea canaliculata* (Gastropoda: Ampullariidae): life-history traits and their plasticity. *Biocell*, 26(1): 83.

Estebenet, A. L. and Martín, P. R. (2003). Shell interpopulation variation and its origin in *Pomacea canaliculata* (Gastropoda: Ampullariidae) from Southern Pampas, Argentina. *Journal of Molluscan Studies*, 69(4): 301-310.

Estebenet, A. L., Martín, P. R. and Burela, S. (2006). Workshop: Biology of Ampullariidae conchological variation in *Pomacea canaliculata* and other South American Ampullariidae (Caenogastropoda, Architaenioglossa). *Biocell*, 30(2): 329-335.

Estebenet, A. L. and Pizani, N. V. (1999). Elección de pareja, cópula y desove en *Pomacea canaliculata* (Gastropoda: Ampullariidae). IV Congr Latinoamer Malacol (Resúmenes): Coquimbo, Chile. p. 91.

Estoy, Jr, G. F., Yusa, Y., Wada, T., Sakurai, H. and Tsuchida, K. (2002a). Effects of food availability and age on the reproductive effort of the apple snail, *Pomacea canaliculata* (Lamarck) (Gastropoda: Ampullariidae). *Applied Entomology and Zoology*, 37(4): 543-550.

Estoy, J., G.F., Yusa, Y., Wada, T., Sakurai, H. and Tsuchida, K. (2002b). Size and age at first copulation and spawning of the apple snail, *Pomacea canaliculata* (Gastropoda: Ampullariidae). *Applied Entomology and Zoology*, 37(1): 199-205.

Fang, L., Wong, P. K., Lin, L. I., Lan, C. and Qiu, J.-W. (2010). Impact of invasive apple snails in Hong Kong on wetland macrophytes, nutrients, phytoplankton and filamentous algae. *Freshwater Biology*, 55(6): 1191-1204. doi: 10.1111/j.1365-2427.2009.02343.x

FAO (2004). Rice and water: A long and diversified story. http://www.fao.org/rice2004/en/f-sheet/factsheet1.htm. Accessed on November 12, 2014.

FAO (2014). World Rice production. Food and Agriculture Organization of United Nations. http://faostat.fao.org. Accessed on November 12, 2014.

Farooq, M., Siddique, K. H., Rehman, H., Aziz, T., Lee, D.-J. and Wahid, A. (2011). Rice direct seeding: experiences, challenges and opportunities. *Soil and Tillage Research*, 111(2): 87-98.

Fleury, A. G. and Drazen, J. C. (2013). Abyssal scavenging communities attracted to *Sargassum* and fish in the Sargasso Sea. *Deep Sea Research Part I: Oceanographic Research Papers*, 72: 141-147. http://dx.doi.org/10.1016/j.dsr.2012.11.004.

Fukatsu, T., Watanabe, T., Hu, H., Yoichi, H. and Hirafuji, M. (2012). Field monitoring support system for the occurrence of *Leptocorisa chinensis* Dallas (Hemiptera: Alydidae) using synthetic attractants, Field Servers, and image analysis. *Computers and Electronics in Agriculture*, 80: 8-16.

Gamarra-Luques, C., Winik, B., Vega, I., Albrecht, E., Catalan, N. and Castro-Vazquez, A. (2006). Workshop: Biology of Ampullariidae An integrative view to structure, function, ontogeny and phylogenetical significance of the male genital system in *Pomacea canaliculata* (Caenogastropoda, Ampullariidae). *Biocell*, 30(2): 345-357.

Gamarra-Luques, C., Giraud-Billoud, M. and Castro-Vazquez, A. (2013). Reproductive organogenesis in the apple snail *Pomacea canaliculata* (Lamarck, 1822), with reference to the effects of xenobiotics. *Journal of Molluscan Studies*, 79(2): 147-162. doi: 10.1093/mollus/eyt011.

Gettys, L., Haller, W., Mudge, C. and Koschnick, T. (2008). Effect of temperature and feeding preference on submerged plants by the island apple snail, *Pomacea insularum* (d'Orbigny, 1839) (Ampullariidae). *Veliger*, 50(3): 248.

Giraud-Billoud, M., Gamarra-Luques, C. and Castro-Vazquez, A. (2013a). Functional anatomy of male copulatory organs of *Pomacea canaliculata* (Caenogastropoda: Ampullariidae). *Zoomorphology*, 132(2): 129-143.

Giraud-Billoud, M., Vega, I. A., Wuilloud, R. G., Clément, M. E. and Castro-Vazquez, A. (2013b). Imposex and novel mechanisms of reproductive failure induced by tributyltin (TBT) in the freshwater snail *Pomacea canaliculata*. *Environmental Toxicology and Chemistry*, 32(10): 2365-2371.

Glover, N. and Campbell, C. (1994). Apple snails in wetland taro. *Pacific Islands Farm Manual, Taro Pest and Disease Leaflet*, 5. pp. 5.

Gnanamanickam, S. S. (2009). Rice and its importance to human life. In: *Biological Control of Rice Diseases*. Springer, Netherlands. pp. 1-11.

Green, R. H. (1979). *Sampling Design and Statistical Methods for Environmental Biologists.* John Wiley and Sons, New York, NY.Pp 253.

Guarnieri, A., Maini, S., Molari, G. and Rondelli, V. (2011). Automatic trap for moth detection in integrated pest management. *Bulletin of Insectology*, 64(2): 247-251.

Gurevitch, J., Fox, G. A., Wardle, G. M. and Taub, D. (2011). Emergent insights from the synthesis of conceptual frameworks for biological invasions. *Ecology Letters*, 14(4): 407-418.

Halwart, M. (1994a). The Golden Apple Snail (*Pomacea canaliculata*) in Asian rice farming systems: present impact and future threat. *International Journal of Pest Management*, 40: 199-206.

Halwart, M. (1994b). *Fish as biocontrol agents in rice: the potential of common carp Cyprinus carpio (L.) and Nile tilapia Oreochromis niloticus (L.)*. Margraf Verlag, Weikersheim, Germany. pp. 169.

Hayes, K. (2009). *Evolution, molecular systematics and invasion biology of Ampullariidae*. (Ph.D. thesis), University of Hawai'i at Manoa, USA. http://proquest.umi.com/pqdweb?did=1884310751&Fmt=7&clientId=36652&RQT=309&VName=PQD.

Hayes, K. A., Joshi, R., Thiengo, S. C. and Cowie, R. H. (2008). Out of South America: multiple origins of non-native apple snails in Asia. *Diversity and Distributions*, 14(4): 701-712.

Hayes, K. A., Cowie, R. H. and Thiengo, S. C. (2009). A global phylogeny of apple snails: Gondwanan origin, generic relationships, and the influence of outgroup choice (Caenogastropoda: Ampullariidae). *Biological Journal of the Linnean Society*, 98(1): 61-76.

Hayes, K. A., Cowie, R. H., Thiengo, S. C. and Strong, E. E. (2012). Comparing apples with apples: clarifying the identities of two highly invasive Neotropical Ampullariidae (Caenogastropoda). *Zoological Journal of the Linnean Society*, 166(4): 723-753.

Heiler, K.C.M., von Oheimb, P.V., Ekschmitt, K. and Albrecht, C. (2008). Studies on the temperature dependence of activity and on the diurnal activity rhythm of the invasive *Pomacea canaliculata* (Gastropoda: Ampullariidae). *Mollusca*, 26: 73–81.

Hirai, Y. (1988). Apple snail in Japan. *Japan Agriculture Research Quarterly*, 22: 161-165.

Ho, K. (2002). Environmental factors of the hibernation sites of *Pomacea canaliculata* in the northernmost population of Japan. *Applied Entomology and Zoology*, 37: 655-661.

Holeck, K. T., Mills, E. L., Macisaac, H. J., Dochoda, M. R., Colautti, R. I. and Ricciardi, A. (2004). Bridging troubled waters: biological invasions, transoceanic shipping, and the Laurentian Great Lakes. *BioScience*, 54(10): 919-929.

Hollas, D. N. (2006). Channeled apple snail *(Pomacea canaliculata*-complex*)* population dynamics, current distribution and reproductive potential on the Texas Gulf Coast. (M.S. Thesis), Stephen F. Austin State University, Texas, USA. http://proquest.umi.com/pqdweb?did=1221730981&Fmt=7&clientId=36652&RQT=309&VName=PQD.

Horgan, F. G., Stuart, A. M. and Kudavidanage, E. P. (2012). Impact of invasive apple snails on the functioning and services of natural and managed wetlands. *Acta Oecologica*, 30(1): e11. http://dx.doi.org/10.1016/j.actao.2012.10.002.

Horgan, F. G., Stuart, A. M. and Kudavidanage, E. P. (2014a). Impact of invasive apple snails on the functioning and services of natural and managed wetlands. *Acta Oecologica*, 54: 90-100.

Horgan, F. G., Yanes Figueroa, J. and Almazan, M. L. P. (2014b). Seedling broadcasting as a potential method to reduce apple snail damage to rice. *Crop Protection*, 64: 168-176.

Horn, K. C., Johnson, S. D., Boles, K. M., Moore, A., Siemann, E. and Gabler, C. A. (2008). Factors affecting hatching success of golden apple snail eggs: effects of water immersion and cannibalism. *Wetlands*, 28(2): 544-549. doi: 10.1672/07-11.1

Howells, R. (2002). Comparative feeding of two species of apple snails (*Pomacea* spp.). *Ellipsaria*, 4(1): 14-16.

Howells, R. G., Burlakova, L. E., Karatayev, A. Y., Marfurt, R. K. and Burks, R. L. (2006). Native and introduced Ampullariidae in North America: History, status, and ecology. In: Joshi, R.C., Sebastian, L.S. (Eds.), *Global Advances in Ecology and Management of Golden Apple Snails*. Philippine Rice Research Institute, Nueva Ecija. pp. 73-112.

Ismail, M. R., Uddin, M. K., Zulkarnain, W. A., Mahmud, M. and Harun, I. C. (2013). Growth and yield responses of rice variety MR220 to different water regimes under direct seeded conditions. *Journal of Food, Agriculture and Environment*, 11(2): 367-371.

Ito, K. (2003). Expansion of the golden apple snail, *Pomacea canaliculata*, and features of its habitat. *Extension Bulletin of Food and Fertilizer Technology Center*, 540: 1-10.

Iwao, S. (1970). Problems in spatial distribution in animal Population ecology. In: Patil, G. P. [ed.] *Random Counts in Models and Structures, 1***.** Pennsylvania State University Press, University Park. Pp. 268.

Jahn, G. C. and Chen, J. A. L. R. (2007). Integrated Pest Management of Rice: Ecological Concepts. In: *Ecologically based integrated pest management*. CAB International, Wallingford, UK. pp. 315-366.

Jahn, G. C. and Khiev, B. (2004). Gall midge in Cambodian lowland rice. *New approaches to gall midge resistance in rice.* International Rice Research Institute and Indian Council of Agricultural Research, Los Baños (Philippines). pp. 71-76.

Jahn, G. C., Almazan, L. P. and Pacia, J. (2005). Effect of nitrogen fertilizer on the intrinsic rate of increase of the rusty plum aphid *Hysteroneura setariae* on rice, *Oryza sativa*, L. *Environmental Entomology*, 34: 938–943.

Joshi, R. C. (2007). Problems with the management of the golden apple snail *Pomacea canaliculata*: an important exotic pest of rice in Asia. In: M. J. B. Vreysen, A. S. Robinson and J. Hendrichs (Eds.), *Area-wide control of insect pests*. Springer, Netherlands. pp. 257-264.

Joshi, R., Delacruz, M., Martín, E., Cabigat, J., Bahatan, R., Bahatan, A., …. and Cayong, A. (2001). Current status of the golden apple snail in the Ifugao Rice Terraces, Philippines. *Journal of Sustainable Agriculture*, 18(2-3): 71-90.

Joshi, R. C., Desmito, M. S., Martín, A. R., Sebastian, L. S. and Coupland, J.B. (2004). Detrimental effects of niclosamide 250EC at pre-seeding in direct-seeded rice culture. *International Rice Research Notes*, 29: 36-37.

Joshi, R., Ponniah, A., Casal, C. and Hussain, N. M. (2005a). Case study on the invasive golden apple snail in ASEAN. *Proceedings: The Way Forward: Building Capacity to Combat Impacts of Aquatic Invasive Alien Species and Associated Trans-Boundary Pathogens in ASEAN countries*. Department of Fisheries, Government of Malaysia. pp. 353-357.

Joshi, R. C., Meepagala, K. M., Sturtz, G., Cagauan, A. G., Mendoza, C. O., Dayan, F. E. and Duke, S. O. (2005b). Molluscicidal activity of vulgarone B from *Artemisia douglasiana* (Besser) against the invasive, alien, mollusc pest, *Pomacea canaliculata* (Lamarck). *International Journal of Pest Management*, 51(3): 175-180.

Joshi, R. C., Martin, E. C., Wada, T. and Sebastian, L. S. (2005c). Role of Golden Apple Snail in organic rice cultivation and weed management. *Proceedings of Scientific Conference on Organic Agriculture*. Adelaide, Australia. pp. 112-115.

Joshi, R. C. and Sebastian, L. S. (2006). *Global advances in the ecology and management of golden apple snails*. Philippine Rice Research Institute, Nueva Ecija, Philippines.

Joshi, R. C., San Martín, R., Saez-Navarrete, C., Alarcon, J., Sainz, J., Antolin, M. M. and Sebastian, L. S. (2008). Efficacy of quinoa (*Chenopodium quinoa*) saponins against golden apple snail (*Pomacea canaliculata*) in the Philippines under

laboratory conditions. *Crop Protection*, 27(3–5): 553-557. doi: 10.1016/j.cropro.2007.08.010

Joshi, R., Martín, A. and Sebastian, L. (2011). Off-season survival of golden apple snails in the Philippines. *International Rice Research Notes,* 30(1).

Karatayev, A. Y., Burlakova, L. E., Padilla, D. K., Mastitsky, S. E. and Olenin, S. (2009). Invaders are not a random selection of species. *Biological Invasions*, 11(9): 2009-2019.

Karraker, N. E. and Dudgeon, D. (2014). Invasive apple snails (*Pomacea canaliculata*) are predators of amphibians in South China. *Biological Invasions*, http://dx.doi.org/10.1007/s10530-014-0640-2.

Keawjam, R. S. (1987). The apple snails of Thailand: aspects of comparative anatomy. *Malacological Review*, 20(1-2): 69-89.

Keawjam, R. S. and Upatham, E. S. (1990). Shell morphology, reproductive anatomy and genetic patterns of three species of apple snails of the genus *Pomacea* in Thailand. *Journal of Medical and Applied Malacology*, 2: 45–57.

Keller, R. P., Drake, J. M. and Lodge, D. M. (2007). Fecundity as a basis for risk assessment of non indigenous freshwater molluscs. *Conservation Biology*, 21: 191–200.

Kenneth, M. B. (2001). Mollusca: Gastropoda. In: J. H. Thorp and A. P. Covich (Eds.), *Ecology and Classification of North American Freshwater Invertebrates (Second Edition)*. Academic Press, San Diego, USA. pp. 297-329.

Kim, H., Bae, S., Lee, G., Park, S., Park, C. and Park, H. (2007). Over-wintering of the apple snail, *Pomacea canaliculata* (Gastropoda: Ampullariidae) and its over-wintering habitat in the Yeongnam District. *Korean Journal of Applied Entomology*, 46(3): 437-444.

Kim, J. R., Hayes, K. A., Yeung, N. W. and Cowie, R. H. (2014). Diverse Gastropod hosts of *Angiostrongylus cantonensis*, the rat lungworm, globally and with a focus on the Hawaiian islands. *PLoS ONE*, 9(5): e94969.

Krishna, A., Biradar Patil, N. and Channappagoudar, B. (2010). Influence of system of rice intensification (SRI) cultivation on seed yield and quality. *Karnataka Journal of Agricultural Sciences*, 21(3): 369-372.

Kunimoto, Y. and Nishikawa, M. (2008). Improvement of the catch efficiency of the apple snail, *Pomacea canaliculata* (Lamarck) (Gastropoda: Ampullariidae) by the trap crop. *Japanese Journal of Farm Work Research (Japan)*, 43: 75-82.

Kwon, E., Ferguson, T. M., Park, S. Y., Manuzak, A., Qvarnstrom, Y., Morgan, S., Ciminera, P. and Murphy, G. S. (2013). A severe case of Angiostrongylus Eosinophilic Meningitis with Encephalitis and Neurologic Sequelae in Hawai'i. *Hawai'i Journal of Medicine and Public Health,* 72(6 Suppl 2): 41-45.

Kwong, K., Dudgeon, D., Wong, P. and Qiu, J.-W. (2010). Secondary production and diet of an invasive snail in freshwater wetlands: implications for resource utilization and competition. *Biological Invasions,* 12(5): 1153-1164. doi: 10.1007/s10530-009-9537-x

Kyle, C. H., Plantz, A. L., Shelton, T. and Burks, R. L. (2013). Count your eggs before they invade: Identifying and quantifying egg clutches of two invasive apple Snail species (*Pomacea*). *PLoS ONE,* 8(10): e77736.

Lacanilao, F. (1990). Reproduction of the golden apple snail (Ampullaridae): egg mass, hatching, and incubation. *Philippine Journal of Science,* 119: 95-105.

Lach, L., Britton, D. K., Rundell, R. J. and Cowie, R. H. (2000). Food preference and reproductive plasticity in an invasive freshwater snail. *Biological Invasions,* 2(4): 279-288.

Lee, G., Paik, C., Noh, T., Seo, H. and Choi, M. (2010). Analysis of damages and rice consumption by golden apple snails (*Pomacea canaliculata*: Ampullariidae) at growth stages of rice. *Korean Journal of Applied Entomology,* 49(4): 343-349.

Leung, L. K. P., Peter, G., Cox, G., Jahn, C. and Nugent, R. (2002). Evaluating rodent management with Cambodian rice farmers. *Cambodian Journal of Agriculture,* 5: 21–26.

Li, D. P., Zhang, H. J., Long, J., Zhang, J. E., Zhao, B. L. and Luo, M. Z. (2014). Impacts of golden apple snail (*Pomacea canaliculata*) on water quality and microbes. *Zhongguo Shengtai Nongye Xuebao/Chinese Journal of Eco-Agriculture,* 22(1): 58-62.

Liang, K., Zhang, J., Song, C., Luo, M., Zhao, B., Quan, G. and An, M. (2013). Integrated management to control golden apple snails (*Pomacea canaliculata*) in direct seeding rice fields: An approach combining water management and rice-duck farming. *Agroecology and Sustainable Food Systems*, 38(3): 264-282.

Listinger, J. A. and Estano, B. (1993). Management of the golden apple snail *Pomacea canaliculata* (Lamarck) in rice. *Crop Protection,* 12: 363-370.

Liu, J., He, Y.-J., Tan, J.-C., Xu, C.-X., Zhong, L., Wang, Z.-G. and Liao, Q.-G. (2012). Characteristics of *Pomacea canaliculata* reproduction under natural conditions. *Ying Yong Sheng Tai Xue Bao = The Journal Of Applied Ecology / Zhongguo Sheng Tai Xue Xue Hui, Zhongguo Ke Xue Yuan Shenyang Ying Yong Sheng Tai Yan Jiu Suo Zhu Ban,* 23(2): 559-565.

Liu, Y., Han, W. and Xian, Z. (2011). Effect of different temperatures on growth, development and feeding of *Pomacea canaliculata*. *Journal of Southern Agriculture,* 42(8): 901-905.

Lloyd, M. (1967). Mean crowding. *Journal of Animal Ecology,* 36: 1-30.

Lowe, S., Browne, M. and Boudjelas, S. (2000). *100 of the world's worst invasive alien species: a selection from the global invasive species database*: Invasive Species Specialist Group Auckland, New Zealand.

Lv, S., Zhang, Y., Liu, H.-X., Hu, L., Yang, K., Steinmann, P., Chen, Z., Wang, L.-Y., Utzinger, J. and Zhou, X.-N. (2009). Invasive snails and an emerging infectious disease: results from the first national survey on *Angiostrongylus cantonensis* in China. *PLoS Neglected Tropical Diseases*, 3(2): e368.

Lv, S., Zhang, Y., Liu, H.-X., Hu, L., Liu, Q., Wei, F.-R., Guo, Y.-H., Steinmann, P. Hu, W., Zhou, X.-N. and Utzinger, J. (2013). Phylogenetic evidence for multiple and secondary introductions of invasive snails: *Pomacea* species in the People's Republic of China. *Diversity and Distributions*, 19(2): 147-156. doi: 10.1111/j.1472-4642.2012.00924.x

Makarim, A. K., Balasubramanian, V., Zaini, Z., Syamsiah, I., Diratmadja, I. G. P. A., Handoko, A., Wardana, I. P. and Gani, A. (2002). Systems of rice intensification (SRI): evaluation of seedling age and selected components in Indonesia. In: Bouman, B. A. M., Hengsdijk, H., Hardy, B., Bindraban, P. S. Tuong, T. P. and Ladha, J. K. (Eds.), *Water-wise rice production*. International Rice Research Institute, Los Baños, Philippines. pp. 129-139.

Maketon, M., Suttichart, K. and Domhom, J. (2009). Effective control of invasive apple snail (*Pomacea canaliculata* Lamarck) using *Paecilomyces lilacinus* (THOM) Samson. *Malacologia*, 51(1): 181-190. doi: 10.4002/040.051.0114

Martín, R. S. (2006). Recent developments in the use of botanical molluscicides against golden apple snails (*Pomacea canaliculata*). In: Joshi, R.C., Sebastian, L.S. (Eds.), *Global Advances in Ecology and Management of Golden Apple Snails*. Philippine Rice Research Institute, Nueva Ecija. pp. 393-403.

Martín, P., Estebenet, A. and Cazzaniga, N. (2001). Factors affecting the distribution of *Pomacea canaliculata* (Gastropoda: Ampullariidae) along its southernmost natural limit. *Malacologia*, 43(1/2): 13-23.

Martín, P. and Estebenet, A. (2002). Interpopulation variation in life-history traits of *Pomacea canaliculata* (Gastropoda: Ampullariidae) in southwestern Buenos Aires Province, Argentina. *Malacologia*, 44(1): 153-164.

Marwato, R. M. and Nur, R. I. (2012). Notes on the distribution of invasive freshwater snail *Pomacea canaliculata* (Lamarck, 1822) and *P. insularum* (d'Orbigny, 1835) in Indonesia. *BIOTROPIA*, 18(2).

Matsukura, K. and Wada, T. (2007). Environmental factors affecting the increase of cold hardiness in the apple snail *Pomacea canaliculata* (Gastropoda: Ampullariidae). *Applied Entomology and Zoology*, 42(4): 533-539.

Matsukura, K., Tsumuki, H., Izumi, Y. and Wada, T. (2008). Changes in chemical components in the freshwater apple snail, *Pomacea canaliculata* (Gastropoda:

Ampullariidae), in relation to the development of its cold hardiness. *Cryobiology,* 56(2): 131-137.

Matsukura, K., Tsumuki, H., Izumi, Y. and Wada, T. (2009). Physiological response to low temperature in the freshwater apple snail, *Pomacea canaliculata* (Gastropoda: Ampullariidae). *Journal of Experimental Biology*, 212(16): 2558-2563.

Matsukura, K., Okuda, M., Cazzaniga, N. J. and Wada, T. (2013). Genetic exchange between two freshwater apple snails, *Pomacea canaliculata* and *Pomacea maculata* invading East and Southeast Asia. *Biological Invasions*, 15(9): 2039-2048.

McCann, M. (2014). Population dynamics of the non-native freshwater gastropod, *Cipangopaludina chinensis* (Viviparidae): a capture-mark-recapture study. *Hydrobiologia*, 730(1): 17-27.

McDowell, W., Benson, A. and Byers, J. (2014). Climate controls the distribution of a widespread invasive species: implications for future range expansion. *Freshwater Biology*, 59(4): 847-857.

Meerburg, B. G., Singleton, G. R. and Leirs, H. (2009). The year of the rat ends—time to fight hunger! *Pest Management Science*, 65(4): 351-352.

Mochinda, O. (1991). Spread of freshwater *Pomacea* snails Pilidae Mollusca from Argentina to Asia. *Micronesica Supplement*, 3: 51-62.

Morallo-Rejesus, B. (2000). Plant Molluscicides: A review with emphasis on the Philippines and China. *Assumption University Journal of Technology*, 3(3): 131-142.

Morrison, W. E. and Hay, M. E. (2011a). Herbivore preference for native vs. exotic plants: generalist herbivores from multiple continents prefer exotic plants that are evolutionarily naïve. *PLoS ONE*, 6(3): e17227.

Morrison, W. E. and Hay, M. E. (2011b). Feeding and growth of native, invasive and non-invasive alien apple snails (Ampullariidae) in the United States: Invasives eat more and grow more. *Biological Invasions*, 13(4): 945-955.

Murphy, S. J., Stonehouse, J., Holt, J., Venn, J., Kamal, N. Q., Rabbi, M. F., …. and Barrion, B. (2006). Ecology and management of rice hispa (*Dicladispa armigera)* in Bangladesh. In: *Perspectives on pests II. Achievements of research under UK Department for International Development, Crop Protection Program 2000–2005*. Natural Resources International Limited, Aylesford, Kent. pp. 162–164.

Musman, M. (2010). Toxicity of *Barringtonia racemosa* (L.) Kernel extract on *Pomacea canaliculata* (Ampullariidae). *Tropical Life Sciences Research*, 21(2): 41-50.

Naklang, K., Shu, F. and Nathabut, K. (1996). Growth of rice cultivars by direct seeding and transplanting under upland and lowland conditions. *Field Crops Research*, 48(2): 115-123.

Naylor, R. (1996) Invasions in agriculture: assessing the cost of the golden apple snail in Asia. *Ambio*, 443-448.

Nelson, G. C., Rosegrant, M. W., Palazzo, A., Gray, I., Ingersoll, C., Robertson, R., Tokgoz, S., Zhu, T., Sulsur, T. B., Ringler, C., Msangi, S. and You, L. (2010). *Food security, farming, and climate change to 2050: Scenarios, results, policy options* (Vol. 172). International Food Policy Research Institute, Washington, USA.

Ng, T. H. and Tan, S. K. (2011). Observations of land snails feeding on the eggs of *Pomacea canaliculata* (Lamarck, 1822) (Mollusca: Gastropoda). *Nature in Singapore*, 4: 79-83.

Ng, T. H., Tan, S. K. and Low, M. E. (2014). Singapore Mollusca: The Family Ampullariidae (Gastropoda: Caenogastropoda: Ampullarioidea). *Nature in Singapore*, 7: 31–47

Nghiem, L. T., Soliman, T., Yeo, D. C., Tan, H. T., Evans, T. A., Mumford, J. D., Keller, R., Baker, R. H., Corlett, R. T. and Carrasco, L. R. (2013). Economic and environmental impacts of harmful non-indigenous species in Southeast Asia. *PLoS ONE*, 8(8).

Nichol, K. (2008). *Invasive apple snail Pomacea insularum: Distribution, vectors, and spread in southeast Texas.* (M.S. Thesis), Stephen F. Austin State University. USA, Texas. http://proquest.umi.com/pqdweb?did=1583167591&Fmt=7&clientId=36652&RQT=309&VName=PQD.

Novarino, W. (2011). A record of small-clawed otters (*Aonyx cinereus*) foraging on an invasive pest species, golden apple snails (*Pomacea canaliculata*) in a west Sumatra rice field. *IUCN Otter Specialist Group Bulletin*, 28(1): 34-38.

Okuma, M., Tanaka, K. and Sudo, S. (1994). Weed control method using apple snail (*Pomacea canaliculata*) in paddy fields. *Weed Research (Tokyo)*, 39(2): 114-119.

Ostrom, A. S. and Chesnes, T. C. (2014). An assessment of submersion as a mechanical control technique of *Pomacea insularum* eggs in Southern Florida, USA. *Natural Resources and Conservation*, 2(1): 6-10.

Pandey, S., Gauchan, D., Malabayabas, M., Bool-Emerick, M. and Hardy, B. (2012). *Patterns of adoption of improved rice varieties and farm-level impacts in stress-prone rainfed arease in South Asia*: International Rice Research Institute, Los Baños, Philippines. pp. 319.

Peng, S., Bouman, B. A. M., Visperas, R. M., Castañeda, A. R., Nie, L., Park, H. (2006). Comparison between aerobic and flooded rice in the tropics: Agronomic performance in an eight-season experiment. *Field Crops Research*, 96: 252-259.

Petney, T., Sithithaworn, P., Andrews, R., Kiatsopit, N., Tesana, S., Grundy-Warr, C. and Ziegler, A. (2012). The ecology of the *Bithynia* first intermediate hosts of *Opisthorchis viverrini*. *Parasitology International*, 61(1): 38-45.

Pheng, S., Jahn, G. C., Khiev, B. and Pol, C. (2012). Response of two rice cultivars to competition from Echinochloa crus-galli. *International Rice Research Notes*, 26(2).

Pizani, N., Estebenet, A. and Martín, P. (2005). Effects of submersion and aerial exposure on clutches and hatchlings of *Pomacea canaliculata* (Gastropoda: Ampullariidae). *American Malacological Bulletin*, 20(1-2): 55-63.

Pointier, J. P., Théron, A. and Imbert-Establet, D. (1988). Decline of a sylvatic focus of *Schistosoma mansoni* in Guadeloupe (French West Indies) following the competitive displacement of the snail host *Biomphalaria glabrata* by *Ampullaria glauca*. *Oecologia*, 75(1): 38-43.

Pointier, J., Theron, A., Imbert-Establet, D. and Borel, G. (1991). Eradication of a sylvatic focus of *Schistosoma mansoni* using biological control by competitor snails. *Biological Control*, 1(3): 244-247.

Posawat, N. (2000). *Efficiency of tea seed cake (Camellia sinensis) and Derris roots (Derris elliptica) extracts for controlling of golden apple snail (Pomacea canaliculata)*. M.Sc. thesis. Faculty of Graduate Studies, Mahidol University, Thailand.

Posch, H., Garr, A. L. and Reynolds, E. (2013). The presence of an exotic snail, *Pomacea maculata*, inhibits growth of juvenile Florida apple snails, *Pomacea paludosa*. *Journal of Molluscan Studies*, 79(4): 383-385.

Preap, V., Zalucki, M. P. and Zahn, G. C. (2006). Brown plant hopper outbreaks and management. *Cambodian Journal of Agriculture*, 7: 17–25.

Qiu, J.-W. and Kwong, K.-L. (2009). Effects of macrophytes on feeding and life-history traits of the invasive apple snail *Pomacea canaliculata*. *Freshwater Biology*, 54(8): 1720-1730. doi: 10.1111/j.1365-2427.2009.02225.x

Qiu, J.-W., Chan, M. T., Kwong, K. L. and Sun, J. (2011). Consumption, survival and growth in the invasive freshwater snail *Pomacea canaliculata*: does food freshness matter? *Journal of Molluscan Studies*, 77(2): 189-195.

Ramakrishnan, V. (2007). *Salinity, pH, temperature, desiccation and hypoxia tolerance in the invasive freshwater apple snail Pomacea insularum*. University of Texas at Arlington.

Ramnarine, I. W. (2003). Induction of spawning and artificial incubation of eggs in the edible snail, *Pomacea urceus* (Muller). *Aquaculture*, 215(1): 163-166.

Ranamukhaarachchi, G. (2011). Study of age of seedlings at transplanting on growth dynamics and yield of rice under alternating flooding and suspension of irrigation of water management. *Recent Research in Science and Technology*, 3(3): 76-88.

Rao, A. N., Johnson, D. E., Sivaprasad, B., Ladha, J. K. and Mortimer, A. M. (2007). Weed management in direct-seeded rice. *Advances in Agronomy*, 93: 153-255.

Rawlings, T. A., Hayes, K. A., Cowie, R. H. and Collins, T. M. (2007). The identity, distribution, and impacts of non-native apple snails in the continental United States. *BMC Evolutionary Biology*, 7:97.

Sala, O. E., Chapin, F. S., Armesto, J. J., Berlow, E., Bloomfield, J., Dirzo, R., ... and Wall, D. H. (2000). Global biodiversity scenarios for the year 2100. *Science*, 287(5459): 1770-1774.

Salleh, N. H. M., Arbain, D., Daud, M. Z. M., Pilus, N. and Nawi, R. (2012). Distribution and management of *Pomacea canaliculata* in the northern region of Malaysia: Mini Review. *APCBEE Procedia*, 2(0): 129-134.

San Martín, R., Ndjoko, K. and Hostettmann, K. (2008). Novel molluscicide against *Pomacea canaliculata* based on quinoa (*Chenopodium quinoa*) saponins. *Crop Protection*, 27(3): 310-319.

Sanico, A. L., Peng, S., Laza, R. C. and Visperas, R. M. (2002). Effect of seedling age and seedling number per hill on snail damage in irrigated rice. *Crop Protection*, 21(2): 137-143.

SAS Institute Inc. (2009). SAS 9.3. SAS Institute Inc, Cary, NC.

Sato, N., Yoshida, M. A., Fujiwara, E. and Kasugai, T. (2013). High-speed camera observations of copulatory behaviour in *Idiosepius paradoxus*: function of the dimorphic hectocotyli. *Journal of Molluscan Studies*, 79(2): 183-186.

Schnorbach, H. J. (1995). The golden apple snail (*Pomacea canaliculata* Lamarck), an increasingly important pest in rice, and methods of control with Bayluscid®. *Pflanzenschutz-Nachrichten Bayer* (English ed.), 48(2): 313-346.

Schnorbach, H. J., Rauen, H. W., Bieri, M., Joshi, R. and Sebastian, L. (2006). Chemical control of the golden apple snail, *Pomacea canaliculata*. In: Joshi, R.C., Sebastian, L.S. (Eds.), *Global Advances in Ecology and Management of Golden Apple Snails*. Philippine Rice Research Institute, Nueva Ecija. pp. 419-438.

Selby, R. D., Gage, S. H. and Whalon, M. E. (2014). Precise and low-cost monitoring of plum curculio (Coleoptera: Curculionidae) pest activity in pyramid traps with cameras. *Environmental Entomology*, 43(2): 421-431.

Seuffert, M. E. and Martín, P. R. (2009). Influence of temperature, size and sex on aerial respiration of *Pomacea canaliculata* (Gastropoda: Ampullariidae) from southern Pampas, Argentina. *Malacologia,* 51(1): 191-200.

Seuffert, M. E. and Martín, P. R. (2010). Dependence on aerial respiration and its influence on micro distribution in the invasive freshwater snail *Pomacea canaliculata* (Caenogastropoda: Ampullariidae). *Biological Invasions,* 12(6): 1695-1708.

Seuffert, M. E., Burela, S. and Martín, P. R. (2010). Influence of water temperature on the activity of the freshwater snail *Pomacea canaliculata* (Caenogastropoda: Ampullariidae) at its southernmost limit (Southern Pampas, Argentina). *Journal of Thermal Biology,* 35(2): 77-84. doi: 10.1016/j.jtherbio.2009.11.003.

Seuffert, M. E. and Martín, P. R. (2013). Juvenile growth and survival of the apple snail *Pomacea canaliculata* (Caenogastropoda: Ampullariidae) reared at different constant temperatures. *SpringerPlus,* 2(1): 1-5.

Sharfstein, B. and Steinman, A. D. (2001). Growth and survival of the Florida apple snail (*Pomacea paludosa*) fed 3 naturally occurring macrophyte assemblages. *Journal of the North American Benthological Society,* 20(1): 84-95. doi: 10.2307/1468190.

Simberloff, D. and Stiling, P. (1996). Risks of species introduced for biological control. *Biological Conservation,* 78(1): 185-192.

Simone, L. R. L. (2004). Comparative morphology and phylogeny of representatives of the super-families of Architaenioglossans and the Annulariidae (Mollusca: Caenogastropoda). *Arquivos do Museu Nacional, Rio de Janeiro,* 62(4): 387-504.

Singh, S. and Singh, G. (2007). Evaluation of different methods of establishment in wheat (*Triticum aestivum*) after different methods of rice (*Oryza sativa*) establishment. *Pantnagar Journal of Research,* 5(2): 36-40.

Snyder, N. F. R. and Snyder, H. A. (1971). Defenses of the Florida apple snail *Pomacea paludosa*. *Behaviour,* 175-215.

Southwood T.R.E. (1978). *Ecological Methods with Particular Reference to the tudy of Insect Populations.* London: Chapman & Hall. 2nd Edition. Pp476.

Suharto, H., Marwoto, R. M., Heryanto, Mulyadi and Siwi, S. S. (2006). The Golden Apple Snail, *Pomacea* spp., in Indonesia. In: Joshi, R.C., Sebastian, L.S. (Eds.), *Global Advances in Ecology and Management of Golden Apple Snails*. Philippine Rice Research Institute, Nueva Ecija. pp. 231-242.

Sule, H., Muhamad, R., Omar, D. and Hee, A. K. W. (2012). Response of *Diaphorina citri* Kuwayama (Hemiptera: Psyllidae) to volatiles emitted from leaves of two rutaceous plants. *Journal of Agricultural Science,* 4(7): 152-159.

Syobu, S., Mikuriya, H., Yamaguchi, J., Matsuzaki, M., Zen, S. and Wada, T. (2001). Estimating the overwintering mortality of the apple snail, *Pomacea canaliculata* (Lamarck) (Gastropoda: Ampullariidae) in a paddy field of Southern Japan using temperature data. *Japanese Journal of Applied Entomology and Zoology*, 45(4): 203-207.

Takashi, W. (2004). Strategies for controlling the apple snail *Pomacea canaliculata* (Lamarck) (Gastropoda: Ampullariidae) in Japanese direct-sown paddy fields. *Japan Agriculture Research Quarterly*, 38(2): 75.

Takeda, N. (1999). Histological studies on the maturation of the reproductive system in the apple snail, *Pomacea canaliculata*. *Journal of Analytical Biosciences*, 22: 425–432.

Tamburi, N. E. and Martín, P. R. (2009). Feeding rates and food conversion efficiencies in the apple snail *Pomacea canaliculata* (Caenogastropoda: Ampullariidae). *Malacologia*, 51(2): 221-232. doi: 10.4002/040.051.0201

Tamburi, N. E. and Martín, P. R. (2011). Effects of food availability on reproductive output, offspring quality and reproductive efficiency in the apple snail *Pomacea canaliculata*. *Biological Invasions*, 13(10): 2351-2360. doi: http://dx.doi.org/10.1007/s10530-011-0047-2

Tanaka, K., Watanabe, T., Higuchi, H., Miyamoto, K., Yusa, Y., Kiyonaga, T., Kiyota, H., Suzuki, Y. and Wada, T. (1999) Density-dependent growth and reproduction of the apple snail, *Pomacea canaliculata*: a density manipulation experiment in a paddy field. *Researches on Population Ecology*, 41: 253-262.

Tanaka, M. O., Souza, A. L. T. and Módena, É. S. (2006). Habitat structure effects on size selection of snail kites (*Rostrhamus sociabilis*) and limpkins (*Aramus guarauna*) when feeding on apple snails (*Pomacea* spp.). *Acta Oecologica*, 30(1): 88-96.

Taylor, L.R., (1961). Aggregation, variance and the mean. *Nature* 189, 732–735.

Taylor, C. M. and Hastings, A. (2005). Allee effects in biological invasions. *Ecology Letters*, 8(8): 895-908.

Teo, S.S. (2001). Evaluation of different duck varieties for the control of the golden apple snail (*Pomacea canaliculata)* in transplanted and direct seeded rice. *Crop Protection*, 20: 599-604.

Teo, S.S. (2002). Selecting plants with molluscicidal properties for the control of the golden apple snail *Pomacea canaliculata* (Lamarck). In: *Proceedings of the 3rd International Conference on Biopesticides*, Kuala Lumpur, Malaysia. pp. 22-26.

Teo, S.S. (2003). Damage potential of the golden apple snail *Pomacea canaliculata* (Lamarck) in irrigated rice and its control by cultural approaches. *International Journal of Pest Management*, 49: 49-55.

Teo, S.S. (2004). Biology of the golden apple snail, *Pomacea canaliculata* (Lamarck, 1822), with emphasis on responses to certain environmental conditions in Sabah, Malaysia. *Molluscan Research*, 24: 139-148.

Teo, S. S. (2005). Golden apple snail (*Pomacea canaliculata* Lamarck, 1819) in Sabah, Malaysia–Current situation and management strategy. Avilabale online: *http://www. pestalert. applesnail. net/conferences/icam07/malaysia.*

Teo, S. S. (2006). Evaluation of different species of fish for biological control of golden apple snail *Pomacea canaliculata* (Lamarck) in rice. *Crop Protection*, 25(9): 1004-1012.

Thiengo, S. C. (1987). Observations on the morphology of *Pomacea lineata* (Spix, 1827) (Mollusca, Ampullariidae). *Memórias do Instituto Oswaldo Cruz*, 82(4): 563-570.

Thiengo, S. C., de Oliveira Simões, R., Fernandez, M. A. and Júnior, A. M. (2013). *Angiostrongylus cantonensis* and Rat Lungworm Disease in Brazil. *Hawai'i Journal of Medicine and Public Health*, 72(6 Suppl 2): 18.

Thomas, K. (1975). Biological control of Salvinia by the snail *Pila globosa* Swainson. *Biological Journal of the Linnean Society*, 7(4): 243-247.

Thresher, R. E. and Kuris, A. M. (2004). Options for managing invasive marine species. *Biological Invasions*, 6(3): 295-300.

Tobias, A. (2012). *Handbook on rice policy for Asia*: International Rice Research Institute, Manila, Philippine. p. 47.

Tsai, H.-C., Chen, Y.-S. and Yen, C.-M. (2013). Human Parasitic Meningitis Caused by *Angiostrongylus cantonensis* Infection in Taiwan. *Hawai'i Journal of Medicine and Public Health*, 72(6 Suppl 2): 26.

Tsai, J. H., Wang, J. J. and Liu, Y. H. (2002). Seasonal abundance of the Asian citrus psyllid, *Diaphorina citri* (Homoptera: PSyllidae) in Southern Florida. *Florida Entomologist*, 85(3): 446-451.

Tscharntke, T., Clough, Y., Wanger, T. C., Jackson, L., Motzke, I., Perfecto, I., Vandermeer, J. and Whitbread, A. (2012). Global food security, biodiversity conservation and the future of agricultural intensification. *Biological Conservation*, 151(1): 53-59.

Tuong, T. P. and Bouman, B. A. M. (2002). Rice production in water-scarce environments. In: Kijne, J. W., Barker, R. Molden, D. (Eds.) *'Water productivity in agriculture: limits and opportunities for improvement'*. The Comprehensive Assessment of Water Management in Agriculture Series, Volume 1, CABI Publishing, Wallingford, UK. pp. 13-42.

Turner, R. and McCabe, C. (1990). Calcium source for protoconch formation in the Florida apple snail, *Pomacea paludosa* (Prosobranchia: Pilidae): more evidence

for physiologic plasticity in the evolution of terrestrial eggs. *The Veliger*, 33(2): 185-189.

United States Geological Survey. (2012). Non indigenous aquatic species database. http://nas.er.usgs.gov/taxgroup/mollusks/default.aspx (accessed on 04.04.12).

Unsworth, R. K. F., Peters, J. R., McCloskey, R. M. and Hinder, S. L. (2014). Optimising stereo baited underwater video for sampling fish and invertebrates in temperate coastal habitats. *Estuarine, Coastal and Shelf Science*. doi: http://dx.doi.org/10.1016/j.ecss.2014.03.020

Vaughan, D. A., Lu, B. R. and Tomooka, N. (2008). The evolving story of rice evolution. *Plant Science*, 174(4): 394-408.

Vega, R., Manalo, D., Caramihan, C., Medialdia, M., Bulatao, M. and Escobin Jr, R. (2007). Duck ranging effects on population and size of golden snails (*Pomacea canaliculata*) before and after transplanting rice. *Philippine Journal of Crop Science*, 32(1).

Vengedasalam, D., Harris, M. and MacAulay, G. (2011). Malaysian Rice Trade and Government Interventions. *Proceedings of Annual Conference of the Australian Agricultural and Resource Economics Society.* Melbourne, Australia. pp. 19.

Wada, T. (1997). Introduction of the apple snail *Pomacea canaliculata* and its impact on rice agriculture. In: *Proceedings of an International Workshop on Biological Invasions of Ecosystems by Pests and Beneficial organisms.* National Institute of Agro-Environmental Sciences, Ministry of Agriculture, Forestry and Fisheries, Tsukuba, Japan. pp. 170-180.

Wada, T. (2004). Strategies for controlling the apple snail *Pomacea canaliculata* (Lamarck) (Gastropoda: Ampullariidae) in Japanese direct-sown paddy fields. *Japan Agriculture Research Quarterly*, 38(2): 75.

Wada, T. and Matsukura, K. (2007). Seasonal changes in cold hardiness of the invasive freshwater apple snail, *Pomacea canaliculata* (Lamarck) (Gastropoda: Ampullariidae). *Malacologia*, 49(2): 383-392.

Wada, T. and Matsukura, K. (2011). Linkage of cold hardiness with desiccation tolerance in the invasive freshwater apple snail, *Pomacea canaliculata* (Caenogastropoda: Ampullariidae). *Journal of Molluscan Studies*, 77(2): 149-153.

Wada, T., R. C. Joshi, and Y. Yusa. (2002). Experiences of Japanese rice farmers with apple snail, *Pomacea canaliculata* (Lamarck) for paddy weeding in transplanted rice: A video documentation. In: *Proceedings of Seventh International Congress on Medical and Applied Malacology*. Los Baños, Laguna, Philippines, p. 22.

Wada, T., Ichinose, K., Yusa, Y. and Sugiura, N. (2004). Decrease in density of the apple snail *Pomacea canaliculata* (Lamarck)(Gastropoda: Ampullariidae) in

paddy fields after crop rotation with soybean, and its population growth during the crop season. *Applied Entomology and Zoology*, 39(3): 367-372.

Wang, Z. and Pei, Y. (2012). Ecological risk resulting from invasive species: a lesson from riparian wetland rehabilitation. *Procedia Environmental Sciences*, 13: 1798-1808.

Wang, Z., Tan, J., Tan, L., Liu, J. and Zhong, L. (2012). Control the egg hatchling process of *Pomacea canaliculata* (Lamarck) by water spraying and submersion. *Acta Ecologica Sinica*, 32(4): 184-188.

Waterhouse, B. M. (2003). Know your enemy: recent records of potentially serious weeds in northern Australia, Papua New Guinea and Papua (Indonesia). *Telopea*, 10: 477-485.

Willocquet, L., Elazegui, F. A., Castilla, N., Fernandez, L., Fischer, K. S., Peng, S., Teng, P.S., Srivastava, R. K., Singh, H. M., Zhu, D. and Savary, S. (2004). Research priorities for rice disease and pest management in tropical Asia: a simulation analysis of yield losses and management efficiencies. *Phytopathology*, 94(7): 672-682.

Wong, L. C., Emrus, S. A., Bashir, B. M. and Tey, J. Y. (2010). Malaysian Padi & Rice Industry: Applications of Supply Chain Management Approach. In. *Proceedings of National Rice Conference.* Swiss Garden Golf Resort, Lumut, Malaysia. pp. 28-30.

Wong, P. K., Kwong, K. L. and Qiu, J. W. (2009). Complex interactions among fish, snails and macrophytes: implications for biological control of an invasive snail. *Biological Invasions*, 11(10): 2223-2232.

Wrona, F. J., Prowse, T. D., Reist, J. D., Hobbie, J. E., Lévesque, L. M. and Vincent, W. F. (2006). Climate change effects on aquatic biota, ecosystem structure and function. *AMBIO: A Journal of the Human Environment*, 35(7): 359-369.

Wu, J. Y., Wu, Y. T., Li, M. C., Chiu, Y. W., Liu, M. Y. and Liu, L. L. (2011). Reproduction and juvenile growth of the invasive apple snails *Pomacea canaliculata* and *P. scalaris* (Gastropoda: Ampullariidae) in Taiwan. *Zoological Studies*, 50(1): 61-68.

Xu, W. B., Zhong, Q. H., Li, L. F., Zhang, J. E., Luo, M. Z., Zhao, B. L. and Zhong, Q. (2011). Differences of female and male *Pomacea canaliculata* in foraging and heterosexual choice. *Chinese Journal of Ecology*, 30(11): 2528-2533.

Yahaya, H., Nordin, M., Hisham, M., Sivapragasam, A., Joshi, R. And Sebastian, L. (2006). Golden apple snails in Malaysia. In: Joshi, R.C., Sebastian, L.S. (Eds.), *Global Advances in Ecology and Management of Golden Apple Snails*. Philippine Rice Research Institute, Nueva Ecija. pp. 215-230.

Yanes F. J., Almazan, M. L. P. and Horgan, F. G. (2014). Reducing seed-densities in rice seedbeds improves the cultural control of apple snail damage. *Crop Protection*, 62: 23-31. doi: http://dx.doi.org/10.1016/j.cropro.2014.04.007

Yang, T.-B., Wu, Z.-D. and Lun, Z.-R. (2013). The Apple Snail *Pomacea canaliculata*, a Novel Vector of the Rat Lungworm, *Angiostrongylus cantonensis*: its Introduction, Spread, and Control in China. *Hawai'i Journal of Medicine and Public Health*, 72(6 Suppl 2): 23.

Yanygina, L. V., Kirillov, V. V. and Zarubina, E. Y. (2010). Invasive species in the biocenosis of the cooling reservoir of Belovskaya Power Plant (Southwest Siberia). *Russian Journal of Biological Invasions*, 1: 50-54.

Yoshida, K., Hoshikawa, K., Wada, T. and Yusa, Y. (2009). Life cycle of the apple snail *Pomacea canaliculata* (Caenogastropoda: Ampullariidae) inhabiting Japanese paddy fields. *Applied Entomology and Zoology*, 44(3): 465-474.

Yoshida, K., Hoshikawa, K., Wada, T. and Yusa, Y. (2013). Patterns of density dependence in growth, reproduction and survival in the invasive freshwater snail *Pomacea canaliculata* in Japanese rice fields. *Freshwater Biology*, 58(10): 2065-2073.

Yoshida, K., Matsukura, K., Cazzaniga, N. J. and Wada, T. (2014). Tolerance to low temperature and desiccation in two invasive apple snails, *Pomacea canaliculata* and *P. maculata* (Caenogastropoda: Ampullariidae), collected in their original distribution area (northern and central Argentina). *Journal of Molluscan Studies*, 80(1): 62-66.

Yusa, Y. (2001). Predation on eggs of the apple snail *Pomacea canaliculata* (Gastropoda: Ampullariidae) by the fire ant *Solenopsis geminata. Journal of Molluscan Studies*, 67(3): 275.

Yusa, Y., T. Wada, and K. Takahashi. (2003). Apple snails in Japan: Their problems, control strategies and possible benefit. In: *Proceedings of the Korean-Japan Joint Conference on Applied Entomology and Zoology*. 28-31 May, 2003, Grand Hotel, Haeundae, Busan, South Korea. p. 105.

Yusa, Y., Joshi, R. and Sebastian, L. (2006). Predators of the introduced apple snail, *Pomacea canaliculata* (Gastropoda: Ampullariidae): their effectiveness and utilization in biological control. In: Joshi, R.C., Sebastian, L.S. (Eds.), *Global Advances in Ecology and Management of Golden Apple Snails*. Philippine Rice Research Institute, Nueva Ecija. pp. 345-361.

Yoshie, H. and Yusa, Y. (2008). Effects of predation on the exotic freshwater snail *Pomacea canaliculata* (Caenogastropoda: Ampullariidae) by the indigenous turtle *Chinemys reevesii* (Testudines: Geoemydidae). *Applied Entomology and Zoology*, 43(4): 475-482.

Zhao, B., Zhang, J., Luo, M. and Song, C. (2012). Study on the super cooling of golden apple snail (*Pomacea canaliculata*). *Shengtai Xuebao/ Acta Ecologica Sinica*, 32(5): 1538-1545.