Introduced, or Non-indigenous, Species and their Ecological Impacts

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The four major causes of worldwide extinction and endangerment of species are habitat destruction, overexploitation, disruption of food chain, and introduced species. Introduced species is often referred to as alien, exotic, nonnative, non-indigenous, or naturalized species, all of which are terms given to organisms that are not indigenous, or native, to a particular area. Instead, introduced species are transported to new locations as the results of human activities and ignorance, along with clothes, agricultural products, and various forms of transportation. For instance, aquatic organisms may be transported to new locations as epifauna, attached to the bottom of ships, or along with the ballast water. Since 1970s, 46 species of non-indigenous species have been introduced around the world in ballast water (Carlton and Geller, 1993 cited in Van Dyke, 2003). Insects, both adults and larvae, are sometimes transported along with agricultural produce, processed, and unprocessed wood. Introduced plant species can disperse over long distances as seeds and spores while some are cultivated only to escape to the wild. It is reported that, in Great Britain, nearly 1,200 species out of 20,000 introduced nonnative plant species have become naturalized (Godfray and Crawley, 1998 cited in Van Dyke, 2003).

Bufo marinus (cane toad)

Although most introduce species fail to establish populations in the new environments, some may experience large population growth and range expansion, become naturalized, and ultimately cause tremendous effects on the native communities by changing community composition, structure, and function. In some cases, introduced species displace, or eradicate, native species, particularly those with specialized niches or small population sizes. Introduced species may prey upon native species that have evolved few or no defense mechanisms against it. On the other hand, ingestion of toxic introduced species, i.e. the infamous *Bufo marinus* (cane toad), may cause mortality due to the fact that native species have not evolved any resistance to the particular toxin. Indirectly, introduced species may cause endangerment or extinction by changing the vegetations or habitats such that they become unsuitable for native species.

In order to become naturalized and establish persistent populations, introduced species must reproduce at high rate under favorable environmental conditions. However, under unfavorable environmental conditions, successful introduced species possess the ability to persist under low densities until improved conditions allow for rapid growth and reproduction. Most importantly, they must be able to exploit the local conditions and resources, which are necessary for rapid reproduction and growth, compared to native species.

It is a general conception that it is better to prevent entries of introduced, or non-indigenous, species rather than eradicating them once they have become naturalized and established persistent populations. In order to prevent entries of non-indigenous species, adequate knowledge regarding the ecosystem and the ecology of the invaders, intensive monitoring at potential point of entries, as well as raising awareness concerning human practices and transportation regulations i.e. treatment of ballast water, are necessary. Nonetheless, once established, it is still possible to control initial infestations of

non-indigenous species. It is necessary to conduct regular inventories, not only to detect small populations of non-indigenous species, but to attain data regarding the native inhabitants of the protected systems. Controlling initial infestations can be accomplished through physical removal, especially female individuals, pesticides, and biological controls. Although effective, pesticides are not species specific and often kill non-targeted, native species. Furthermore, they persist in the environment and may pose long-term threats. Likewise, biological controls may create chains of events with negative consequences. When preventions and eradications fail, it is necessary to determine ways in which the distribution and abundance of non-indigenous species can be reduced, and their negative effects lessened (Van Dyke, 2003).

Case Study: A Comparative Study of Dietary Habits of the Introduced Cane Toad, *Bufo marinus*, and Several Native Anurans on Ishigakijima, Southern Ryukyus*

The Cane toad, *Bufo marinus*, is a large bufonid toad originally distributed from southern North America (southern Texas and western Mexico) to central South America (southern Brazil). Since the early period of the 19th Century, this toad has been artificially introduced to various nonnative areas as a biological agent to control sugar cane pests. As a result, we now can see a number of feral populations, occasionally showing extremely high individual density, of *B. marinus* in the Caribbean Islands, and tropical and subtropical regions of Oceania (including northeastern Australia) and eastern Asia. In Japan, this toad was first introduced to a few oceanic islands (the Daito and Ogasawara Islands) before and immediately after the World War II, and finally to Ishigakijima Island in the southern part of the Ryukyu Archipelago in 1978. This species currently occurs in relatively high density almost all over the island.

Despite the reported abundance of *B. marinus* and the predicted adverse effects imposed on the native fauna, of Ishigakijima, studies pertaining to the relative density and distribution, if any, are scarce. Moreover, studies pertaining to niche overlaps, in terms of feeding habits and competition for food, between *B. marinus* and native anurans, have not yet been conducted. This study examined observation frequencies, and potential and actual prey items of *B. marinus* and native anuran species at three sites with different habitat conditions (pond, forest, and rice paddy field) on Ishigakijima Island. Our purposes were: (1) to clarify the diversity, variation, and selectivity of prey animals in each of these species; (2) to elucidate the extent of dietary overlap between *Bufo marinus* and native anurans; and (3) to estimate the extent of influences of the former on the latter accordingly.

At all three sites, *B. marinus* was found in substantial densities together with a few species of native frogs, confirming their broad sympatric occurrences within Ishigakijima Island. Stomach contents of *B. marinus* largely consisted of insects and other invertebrates. Comparisons in relative abundance of animal taxa from *B. marinus* stomachs and those from random sampling at same sites indicated significant prey selectivity in this toad. This suggests that the predation of this toad affects some particular invertebrates over the others. Stomach contents exhibited much greater values in mass and diversity in *B. marinus* than in any of the native anurans. Moreover, dietary overlap was greater between *B. marinus* and the native anurans than between any pair of the latter at each site. These results predict negative impact of *B. marinus* on the native anurans through dietary competition.

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References

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