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**Economic Relationship between Malaria and
the Introduction of Guppies in the Peruvian Amazon**

Introduction:

The introduction of some exotic species is cited as helpful by Asian Development Bank (2013) to combat mosquito diseases such as Malaria. According to the Asian Development Bank, by introducing small fish called guppies in the household water, the cases of dengue fever has decreased, and this method is proven to be successful in Cambodia and Laos. Guppies have been introduced to many different countries often with the goal of reducing the spread of malaria because they are expected to eat mosquito larvae. However, the World Bank report states that the Peruvian government adopts different ways to combat malaria but not larva control and has spent a considerable amount of money to reduce the number of malaria cases in Peru. According to the Ministry of Health in Peru, government spent about \$29.2 million in 1998 to reduce malaria cases through different ways including giving out free treatment for malaria as part of citizens' welfare. Given that the use of guppies is suggested to be a cheaper method of controlling malaria, it is worthwhile to investigate whether the government should adopt guppies as a control measure.

As much as guppies have been seen to bring positive changes in combating mosquito diseases such malaria and dengue fever, data that I have collected in Iquitos show no relationship between Malaria cases and the introduction of guppies. Instead, guppies have become a source of concern because some have escaped into the natural environment and are causing changes in the ecosystem by displacing native fish species such as killifish. Throughout my two weeks of research in the Peruvian Amazon, Loreto region, I observed an abundance of guppies in open freshwater streams where they are not naturally meant to be. This report will study the economic relationship between malaria and guppies by examining data of malaria cases and the economic costs of introducing guppies.

Hypothesis:

Since guppies can reproduce quickly and are able to live in different environments, the number of guppies could have increased throughout these past 70 years. With the increase in the number of guppies, the number of Malaria cases reported should decrease, especially in the Loreto region.

Method: Site visits and data from articles

1. I went to Hospital Apoyo Iquitos to understand more about the malaria cases and what actions the government has taken to combat malaria. However, records of malaria cases are only available for the past two years, 2013 and 2014, because the department does not have records of past years.
2. I continued to search for the relationship between guppies and Malaria cases at Universidad Nacional de Amazonia Peruana from theses and papers published in Peru. I found Malaria cases in Loreto, the Peruvian Amazon region, from 1997-1999 with the highest number of 77056 in 1997 and the total cost that government spent annually to prevent Malaria in 1998 was around \$37 millions.
3. I went to the Ministry of Fisheries to find out more information about the exportation and importation of different fish, particularly guppies. Through this process, I also tried to investigate the economic benefits that the guppies generate to the regional economy. Unfortunately, the Ministry did not have data because they were burnt "accidentally," and many were not documented well. Hence, data in terms of the exportation and importation of guppies in Iquitos cannot be fully obtained.

4. In order to understand the economic influence of guppies, I went to Amazon Tropical Aquarium, one of the main fish exporters in Iquitos. There, I learned about guppies as a source of food for many different fish, which is preferred to other native fish because of its availability and low cost. By using guppies, many local fish farmers can earn more profit because 500 guppies only cost 2 soles (less than a dollar). Fish farmers could use native fish such as killifish as a replacement for guppies if guppies did not exist, and the cost of killifish is also not considerably high. However, guppies are still much preferred in the region because they are highly fecund and they are more resilient to wide range of environmental conditions, which makes them easily accessible everywhere.

Analysis:

During the visit to the Ministry of Fisheries, I found that there is no government intervention to prevent the outflow of guppies into nature. Due to guppies ability to reproduce in a short amount of time and to adapt to harsh environments, the lack of prevention on outflow of guppies allows them to spread so quickly that they are now easily accessible in rivers, drainage systems, and streams. According to the Food and Agriculture Organization of United Nations (FAO), guppies were introduced in Peru in the 1940s.

Graph 1 shows the trend of the malaria cases (in millions) in Peru from 1939 to 1999 (Peru's Ministry of Health). According to the trend, the number of malaria cases decreased gradually from 1944 to 1969, and slowly increased until 1987 before the number of malaria cases shot up significantly in 1988. From the graph, it seems that the introduction of guppies helped during that period, if any, to reduce the number of malaria cases. Granted that some native fishes eat mosquito larvae as well, the introduction of guppy fish in this period should thus have helped reduce mosquito larvae more than the years before they were introduced. Hence, the dramatic decrease in mosquito larvae should be directly proportionate to the reduction of malaria cases in Peru. Even though Graph 1 represents the entire country, most of the malaria cases represented in Graph 1 came from Loreto, the region where I was conducting the research. Also from Graph 3, it can be observed that Loreto region contribute to the majority of the malaria cases in Peru. This is also supported by Graph 4, which shows that Loreto region has the highest malaria cases in 1999. Graph 2 gives more specific numbers of malaria cases from 1992 to 1998 due to a specific type of parasite known as *Plasmodium falciparum* that causes malaria in humans.

From the graphs, it is not completely clear whether guppies help reduce malaria. Even though the number of malaria cases reduced from 1944-1969, malaria cases increased after this period with the presence of guppies in the later period. Without more information on the data, no concrete conclusion can be reached to support this relationship. Hence, the Peruvian government should try to keep a good record on the number of malaria cases in order for this investigation to be more conclusive and accurate in the near future.

Besides that, one of the negative consequences caused by having guppies in the wild is that they eat other native fish's larvae. This can create an imbalance in the ecosystem in the native region because the number of native fishes would decrease in the long run. During my research in Loreto, I observed this phenomenon in areas where there were guppies. I saw no killifish.

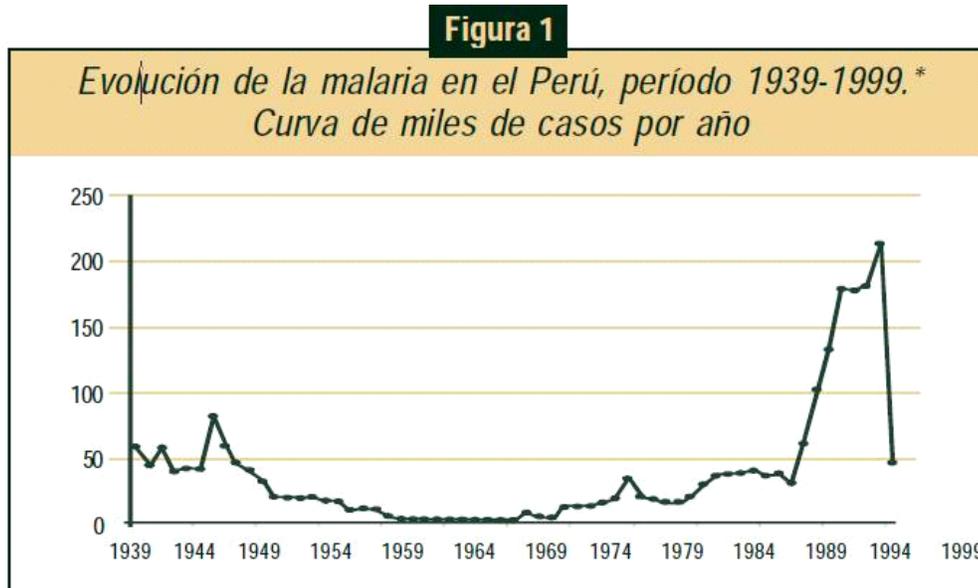
One benefit of bringing guppies to the native region is that it has been a food source for other fish. Nevertheless, only some fish farmers apply this practice. Majority of the fish farmers whom we visited only use fishmeal rather than feeding their fish with guppies. The demand of using guppies as food is lower than the supply of guppies. As the supply of guppies continues to grow, the more guppies eat larvae of native fishes. From this comparison, the overall cost outweighed the overall benefits of guppies in Loreto. Thus, it is not beneficial for the government to use guppies as a way to combat Malaria.

In conclusion, throughout my two weeks of research and observation in Loreto region, guppies did not show a direct negative relationship with Malaria case. Even though guppies do contribute to small

amounts of income from exportation and importation in Peru, the outflow of guppies to the wild may lead to reduction and even distinction of native fishes such as killifish.

Appendix:

Graph 1

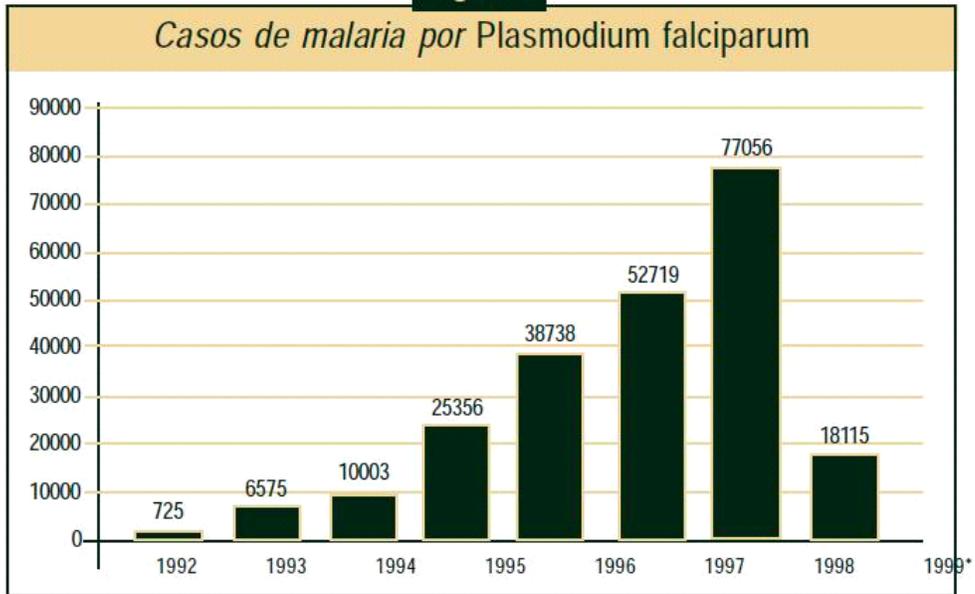


Fuente: OGE-MINSA

(*) Hasta la semana epidemiológica 16

Graph 2

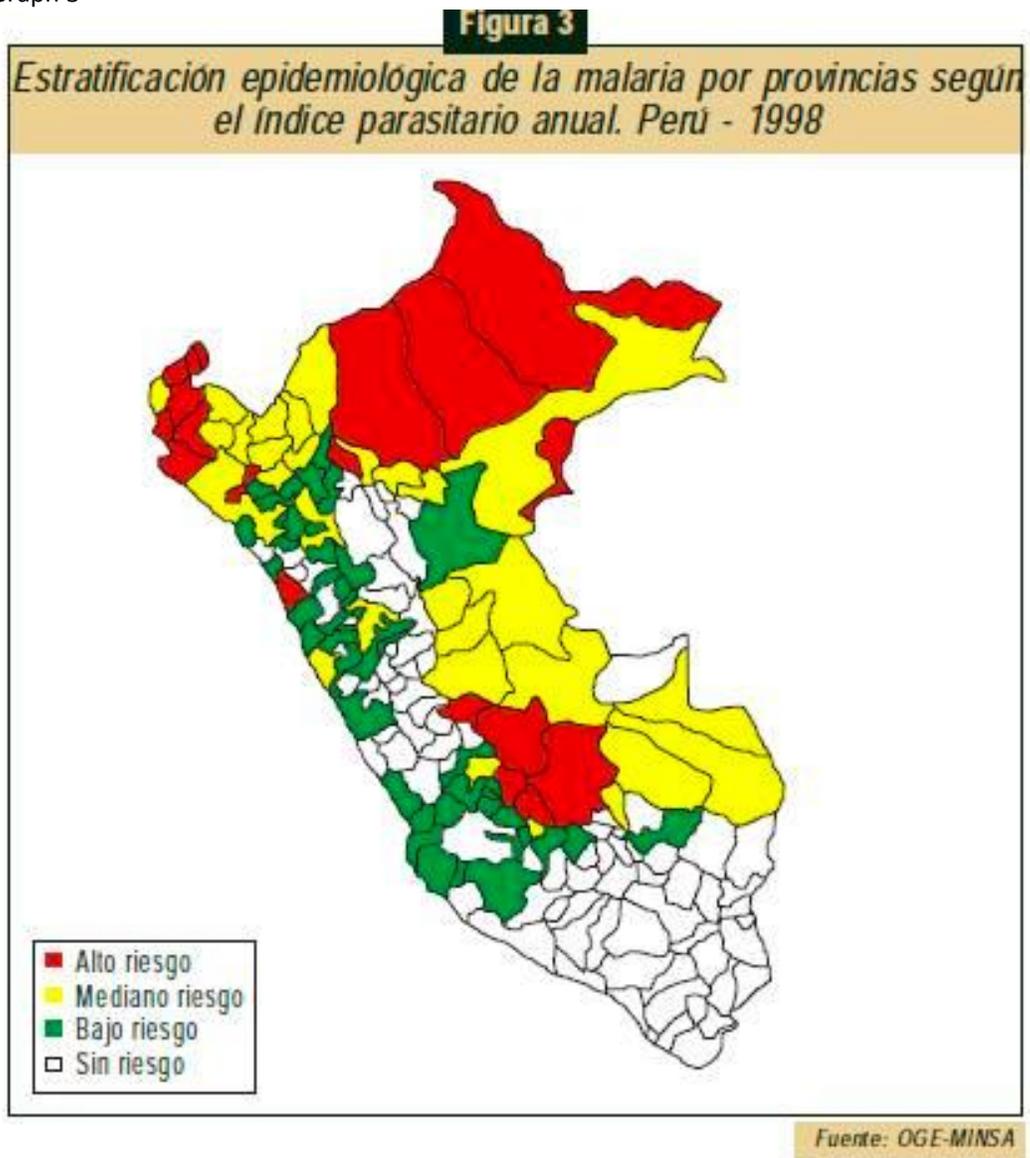
Figura 2



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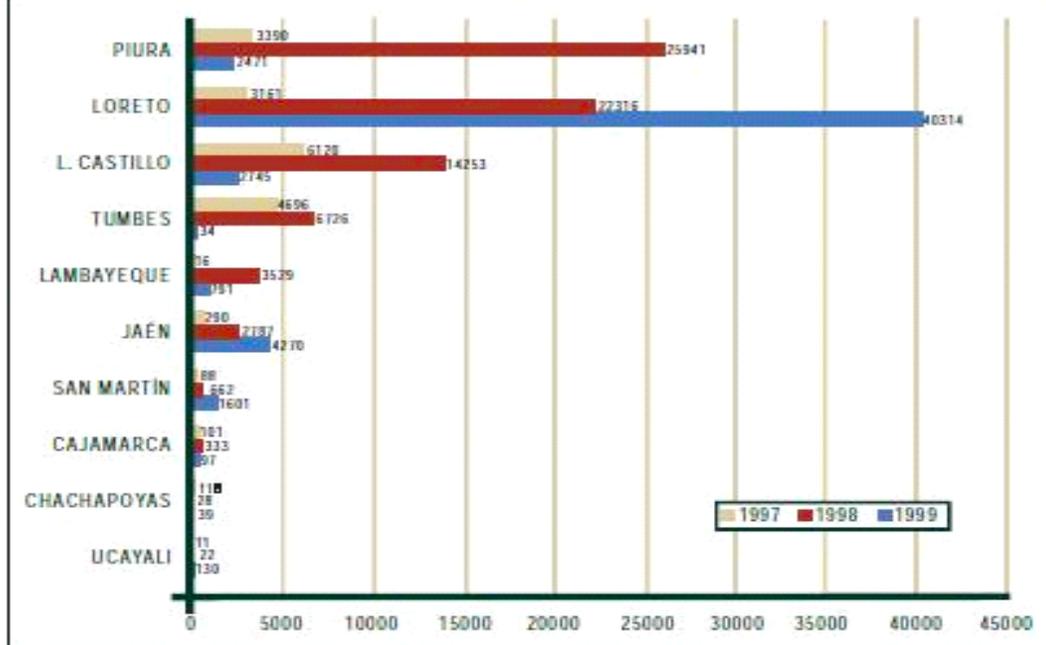
Graph 3



Graph 4

Figura 4

*Malaria por P. falciparum, subregiones más afectadas, 1997-1999**



Fuente: OGE-MINSA

(*) Datos de 1999 hasta la semana 16