Predation of Olive Ridley (*Lepidochelys olivacea*) Nests by Vertebrates and Crabs at Playa Nancite, Costa Rica

Kristen Nelson
Macalester College
Advisor: Claudette Mo
ACM Tropical Field Research
May 1996

Abstract. This study documents the predation of olive ridley sea turtle (*Lepicochelys olivacea)* nests on Playa Nancite, Guanacaste Conservation Area, Costa Rica Data were collected between February 27 and April 24 Predator frequency was determined by examining predated nests for tracks and distinctive ways of excavation The date, egg development stage, number of crab holes within a one meter radius leading to the nest, and predator were recorded for each predated nest found The predators in decreasing order of frequency were coyote (*Canis latrans*), racoon (*Proycon lotor*), coati (*Nasua narica*), humans (*Homo sapiens sapiens*), and caracara (*Polyborus plancus*). It was found that predation during the rainy season by vertebrates was not related to predation by ghost crabs (*Ocypode occidentalis*) Nest stage of embryonic development was related to type of predator There was not a significant difference between number of nests predated, frequency of predators, and nest stages predated before and after an arribada

Resumen Se realizó una investigacion acerca de la depredacion de los nidos de la tortuga lora (*Lepidochelys olivacea*) en Playa Nancite, y bicada en el Area de Conservación Guanacaste, Costa Rica Se recogieron los datos entre el 27 de febrero y el 24 de abril de 1996. De cada nido encontrado abierto se tomaron datos de fecha, huecos de congrejos, edad de los nidos, el depredador y la secuencia. Los depredadores por decrescente orden de frecuencia fueron coyotes (*Canis latrans*), mapaches (*Procyon lotor*), pizotes (*Nasua narica*), humanos (*Homo sapiens sapiens*), y caracaras (*Polyborus plancus*) Se encontró que durante la epoca seca, la depredacion por vertebrados no tenía relación con la depredación por los congrejos (*Ocypode occidentalis)* Las etapas o edads de los nidos no estuvieron relacionadas con el tipo de depredador. No se encontró una diferencia significativa entre el numero de nidos abiertos, la frecuencia de los depredadores, y las etapas de los nidos abiertos antes y despues de un arribada

Introduction

Of the seven species of sea turtles, only the Kemp's ridley (*Lepidochelys kempii*) and the olive ridley (*Lepidochelys olivacea*) nest in large congregations called arribadas These arribadas occur in only a few areas in Mexico, Nicaragua, Panama, India, and Costa Rica. The arribadas of olive ridleys in Costa Rica are some of the largest in the eastern Pacific, and occur at Playa Ostional and Playa Nancite, making these beaches very important to the survival of olive ridleys

Many of the nests of the olive ridleys are destroyed by natural predators. Playa Nancite is isolated from humans and a study done by Cornelius (1986) found that the main vertebrate predator was the coati (*Nasua narica*), which was responsible for 80 percent of nest predation The racoon (*Proycon lotor*) and the coyote (*Canis latrans*) also predated many nests One species of ghost crab (*Ocypode occidentalis*) will also break into nests and feed on eggs, and those remaining are often fed upon by fly larvae or fungus The caracara (Polyborus plancus) has also been observed making unsuccessful attempts at digging up nests (Cornelius 1986).

The coyote has recently replaced the coati as the major predator of olive ridley nests (Nowak and Mo 1994). Cornelius (1986) found most nests were preyed upon by vertebrate predators only after they had been invaded by ghost crabs and had begun to rot He believed that vertebrates were able to find the nests due to the smell of decay. Some animals are also able to use other cues to detect nests. Before hatching, the sand above the nests becomes less compact, allowing heavier animals like coyotes to detect their presence (Cornelius 1986). Stancyk (1981) also observed that racoons, foxes, and dogs predated more nests closer to emergence, due to release clues.

In this study I determined the frequency of vertebrate predation of olive ridley nests, the relation between crab holes and nest predation by vertebrates, the sequence of nest predation, the stage of embryo development in predated nests, the frequency of nest predation, and its age in relation to an arribada event

Study Site

The Area of Conservation, Guanacaste (ACG) protects the Nancite valley and beach. The Nancite valley covers 300 ha of the Santa Rosa sector of ACG. The beach, which is 1050 meters long, is located on the south west portion of the valley and runs from southeast to northwest There are two estuaries, one of which transects the middle portion of the beach, and the other is in the northern portions of the beach. This study was conducted during the dry season, therefore neither of these estuaries cut through the beach to the ocean. The vegetation bordering the northern 300 meters of the beach consists of button mangroves (*Conocarpus erectus*). In the middle 500 meters of the beach there are red mangroves (*Rhizophora mangle*). Other dominant vegetation in the high beach zone are hibiscus (*Hibiscus tileaceus*), brazilwood (*Haematoxylon brasiletto*), madrone (*Gliricidia sepium*), and seashore salt grass (*Distichlis spicata*) (Cornelius et al 1985).

Methodology

Research was conducted at Playa Nancite between February 27 and March 16, 1996 and March 19 and April 24 for a total of 39 days of research.

The beach was observed from Silla de Mimi (Figure 2) overlooking the beach from 0500h to 0700h. Binoculars were used to observe predators and data were taken on their activities and interaction Data were taken on recently predated nests between 0700h and 0800h, 1200h and 1300h, and 1600h and 1700h The date, time, and number of recently predated nests were recorded The nests predated the night before were marked with an upright stick 1.5 m away from the nest These nests were given a number and entered on the data sheet Data was recorded on the location of the nest, the stage of the nest, the number of crab holes present in a one meter radius around the nest, and how many of these holes lead to the nest. Type of predator was determined by how the nest was entered and tracks around the nests The primary predator was determined by the fresher tracks in nests that had been predated more than once The number of crab holes was counted in a one m. radius around the nest. Dry sand, which was much lighter in color than the wet sand, was used to determine if any crab holes led to the nests. The dry sand was poured down the holes until they were filled, and then the sand was scraped away, layer by layer, until it could be determined if the hole reached the nest. The age of the nest was determined by breaking open up to ten eggs The nest was then placed into one of several predetermined categories described in Table 1

Table 1: Categories of Predated Nests

Name of Category	Age of Nest	Description
Fresh	1 to 3 days	no embryo present, bright yellow yolk, distinctive odor
Non Developing	any age possible	no embryo present, no distinctive odor, dull yellow yolk
Slightly Developed	3 to 17 days	embryos present without carapaces
Moderately Developed	18 to 26 days	embryos with carapaces, lacking pigment
Highly Developed	27 to 55 days	embryos with carapaces, pigment present, unhatched
Neonates	55 or more days	turtles have already hatched and may or may not have yolk sacs
Rotten	any age possible	distinct odor, gas released from eggs, maggots may be present, yolk and white may be solid due to heat

During the first week observations of night predators were done from 1700h until 2300h This was done during the time between the first quarter and the full moon These observations took place at the Silla de Philippe, a high chair placed in the middle of the beach After the first week these observations only occurred between 1700h and 1830h

Data were analyzed using the program STATGRAPHICS Plus to perform a chi square test to determine if there was a difference in frequency in predators. Three ANOVA tests were executed to determine if there was a difference in the nest predation before and after the arribada A two-way ANOVA test was also performed to determine if there was a relationship between predators and nest stage Statgraphics (version 4.0) was used tocreate a contingency table to determine if the mean number of nests differed between species and nest stages BIOM software was also used to carry out twenty-five replicative G-tests, to determine if there were any prominent patterns in predation in nests that were predated more than once.

Results

It was found that predation rates varied greatly between species of predator (X^2=343; df=4, p<0 001) (Figure 3).

Of the 202 predations, only nine of the nests had crab holes and only one of these holes led to the nest No statistical test was needed to determine that vertebrate predation was not related to crab predation

Of the nests predated more than once the patterns that had a higher frequency were coyote-coyote, racoon-coyote, and coyote-racoon (df=1; p<.01).

The stage of the nests predated was dependent on the species of predator (X^2=49 5, df=24. p=0 0016) (Figure 4) The mean number of nests predated upon differed between species (F=7 4. df=4,24; p=0 0005) The mean number of nests predated upon differed between stages of development (F=2.61, df=6,24, p=0 043)

The stage of nests predated seventeen days before the arribada was not different from the seventeen days after the arribada (F= 2 40, df= 1,8, p= 1596) The number of nests predated by all predators five days before the arribada was not different from five days after (F= 0.31, df= 1,8, p= 0.50). The number of the nests five days before the arribada was not different from five days after (F= .46; df= 1,12; p= 5171).

Through personal observation it was found that during the time of this study three adults were predated on the beach during three separate occasions During these three nights the total numbers of new nests laid were seven, 16, and 94.

Discussion

In this study it was found that there were five primary vertebrate predators of olive ridley nests They were, in order of decreasing frequency: coyote, racoon, coati, human, and caracara These results differed from those of Cornelius (1986), in which he found the coati was the main predator and from Nowak and Mo (1994), in which the coati was second and the racoon was third Through morning observations it was also documented that a caracara is capable of opening a nest and eating eggs. This act has not been documented before.

Cornelius (1986) believed that the amount of vertebrate predation was related to the amount of crab predation. In his theory, the crabs would enter a nest, eating only a few eggs.

Their entrance allows for flies to enter and lay eggs The eggs begin to rot, giving off an odor detectable by vertebrate predators While this may have been true during the rainy season, when Cornelius was doing his study, it was not true during the dry season During this time many of the nests predated were on the high beach which had sand too dry for crabs to create holes

The three patterns of nest predation that had a higher frequency than expected were coyote-coyote, racoon-coyote, and coyote-racoon It is possible that the predators used the visual cues from the other predators to determine nest location If this were true, however, other patterns would most likely be observed The sample size for this test was only 25 nests Perhaps if there was a larger sample size, other patterns would have developed. An attempt was made to determine how the presence of predators affect one another by watching the beach on nights when there was a strong amount of moon light Unfortunately, even with moon light, it is impossible to see the entire beach, making night observations almost impossible without infrared night vision goggles. However, there was evidence of a fight between a coyote and a racoon in tracks on the beach one morning.

The coyotes predated a large number of fresh nests and a large amount of rotten nests with a smaller but significant number of highly developed nests The fresh nests and rotten nests were most likely detected by smell, while the highly developed nests were probably detected by the less dense sand above them collapsing when the coyotes stepped on them. Several nests were also observed that the coyotes had begun to open, but subsequently left alone after hitting rotten eggs, suggesting that although they can detect rotten eggs by smelling them, they do not necessarily prefer them to other types of eggs. Racoons also predated a large number of fresh and rotten nests. The racoons were most likely able to smell the rotten eggs. Racoons are also able to detect nests using visual cues (Cornelius 1986) There was no significant difference between the nest stages of the nests predated by coatis, caracara, and humans This was most likely due to a small sample size If there had been more human predation, all of the nests would have most likely been fresh, due to the fact that humans prefer fresh eggs, and can only detect nests with visual cues

It was expected that the stage of the nests predated would be different before and after the arribada with more highly developed and rotten eggs being predated before the arribada and more fresh and slightly developed eggs being predated upon after the arribada Although there was not a statistical difference between these two there is a tendency for fresh eggs over rotten eggs after an arribada (Figure 5) A larger sample size might show a statistical difference between these two. There also may not have been much of a difference due to the small size of the arribada The predator frequency did not change before or after the arribada either This leads me to believe that the event of an arribada does not have an effect on the type of predators present. The amount of predation did not increase after the arribada This suggests that an arribada increases the chances of an individual nest surviving because although the number of predations did not change the percentages of nests being predated would have decreased The amount of predation did not increase because Playa Nancite is isolated from the surrounding park, making it difficult for predators to migrate into the area Therefore, an arribada would not necessarily increase the amount of predation

Conclusion

Playa Nancite is an important nesting ground and is vital to the survival of the olive ridley sea turtles Being isolated from human settlements, it is an area where natural predation of nests can be studied

The coyote is the main predator of the olive ridley sea turtles nests at Playa Nancite Also, unlike what was previously thought, caracaras are capable of opening nests.

During the dry season crab predation is not related to the predation by vertebrate predators. Coyotes, racoons, and coatis are capable of finding fresh nests either by scent or visual cues They are also capable of finding and then digging up rotten nests due to scent. Because sand above hatching nests is less dense, coyotes are capable of finding them by stepping on them

In an isolated area such as Nancite predation does not change greatly after an arribada This is because of lack of migration by predators

Through personal observation it was found that the adult turtles that were predated did not nest during the nights of the arribada, nor were they the only turtles which nested during the night. This suggests that both arribadas and solitary nesting offer protection to nesting turtles.

Recommendations

This study has suggested many possibilities for future studies. It would be interesting to compare crab predation to vertebrate predation throughout the year It would also be valuable to study the predation of adult females while they come to nest, not only to compare the number killed per night with the number that nested, but also to study trends in predators.

Acknowledgments

I would like to thank my advisor Claudette Mo for all her help during this project. I would also like to thank Chris Vaughan for his assistance during the writing process Mike McCoy was very helpful with the statistics and Judith Magnan guided me through the use of the computer programs. I am also grateful to the Area of Conservation, Guanacaste for allowing me to study in such a beautiful place as Nancite I would like to thank Laura Shaw and Sonya Smith for keeping me company during my study I would also like to thank the park guards for checking up on us and helping when we had problems with our water.

Liturature Cited

Cornelius, Stephen E. 1986. The Sea Turtles of Santa Rosa National Park. Fundación de Parques Nacionales, Costa Rica.

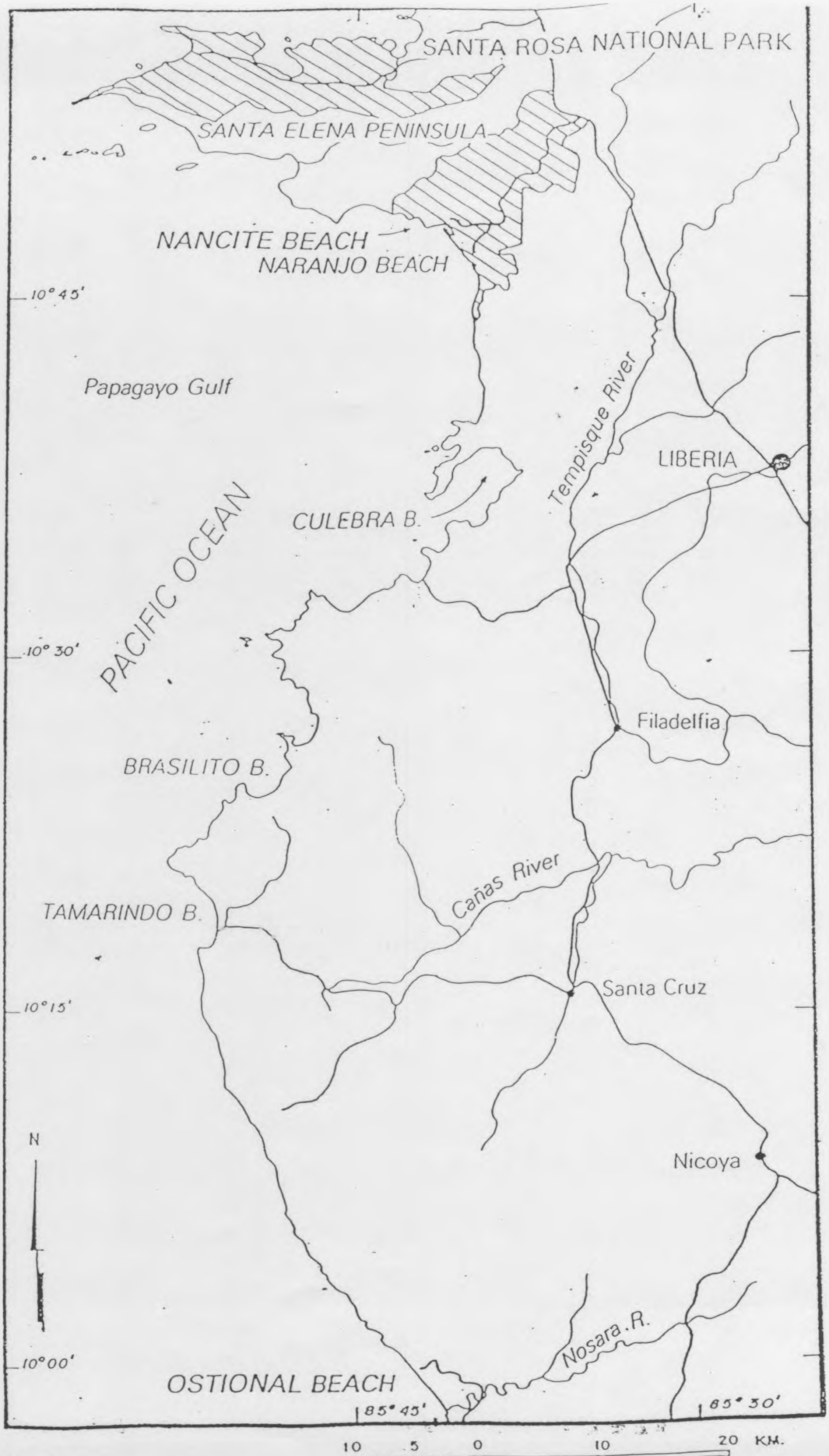
Cornelius, S.E., M.A. Ulloa, T.C. Castro, M. Mata del Valle and D.C. Robinson. 1991. "Management of Olive Ridley Sea Turtles (*Lepidochelys olivacea*) Nesting at Nancite and Ostinal, Costa Rica." Pages 111-135 in J.G. Robinson and K.H. Redford, eds. Neotropical Wildlife Use and Conservation. University of Chicago Press, Chicago.

Nowak, Gretchen and Claudette Mo. 1994. "Comparison of nest predation frequencies of the olive ridley sea turtle (*Lepidochelys olivacea*) by vertebrate predators at Playa Nancite, Costa Rica." ACM Tropical Field Research, Costa Rica.

Syancyk, Stephen E. 1981. "Non Human Predators of Sea Turtles and Their Control." Pages 139-143 in Bjorndal, Karen A. ed Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington D.C.

Webber, Naomi and Claudette Mo. 1995. "Predation frequencies of leatherback sea turtle (*Dermochelys coriacea*) nests on Playa Grande, Costa Rica." ACM Tropical Field Research, Costa Rica.

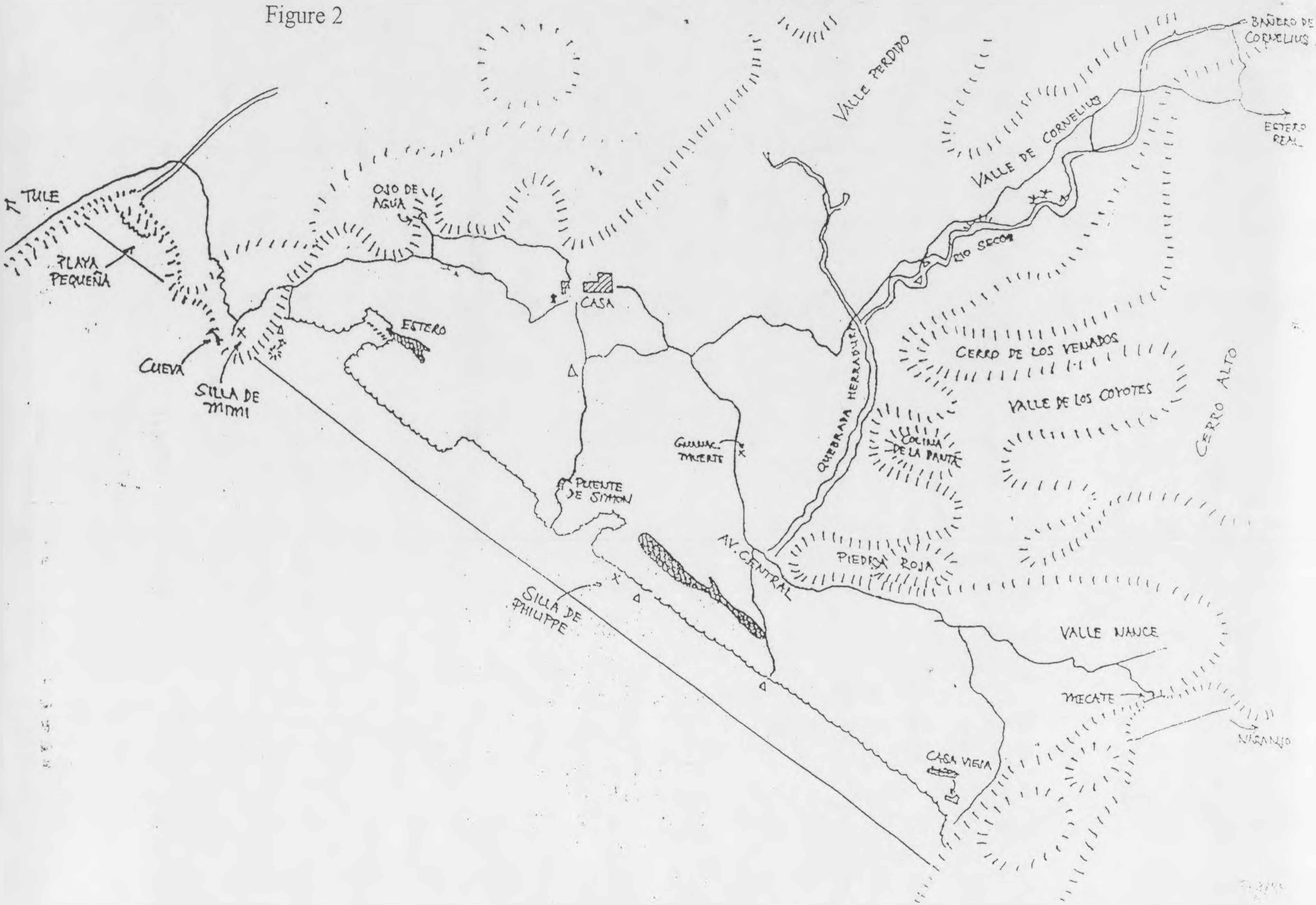
Figure 1



I.G.N./1985

Taken from: Cornelius, S.E. 1986. The Sea Turtles of Santa Rosa. Fundacion de Parques Nacionales, Costa Rica.

Figure 2



C 2/95 Philippe Mayor
Ammonite Ltd. 1995

Figure 3

The Percentages of Nests Predated by Each Species

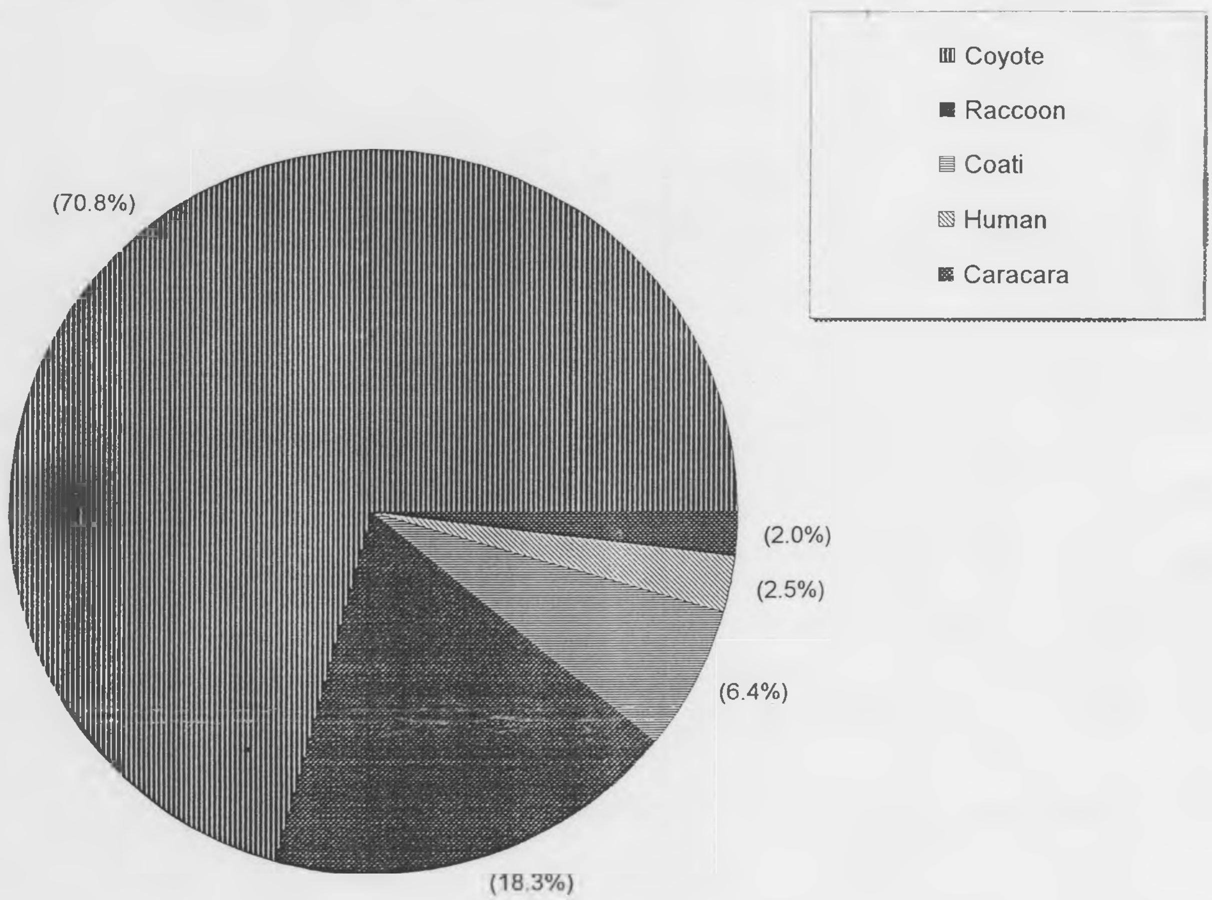


Figure 4: The Percentage of Each Egg Stage Predated by Each Predator

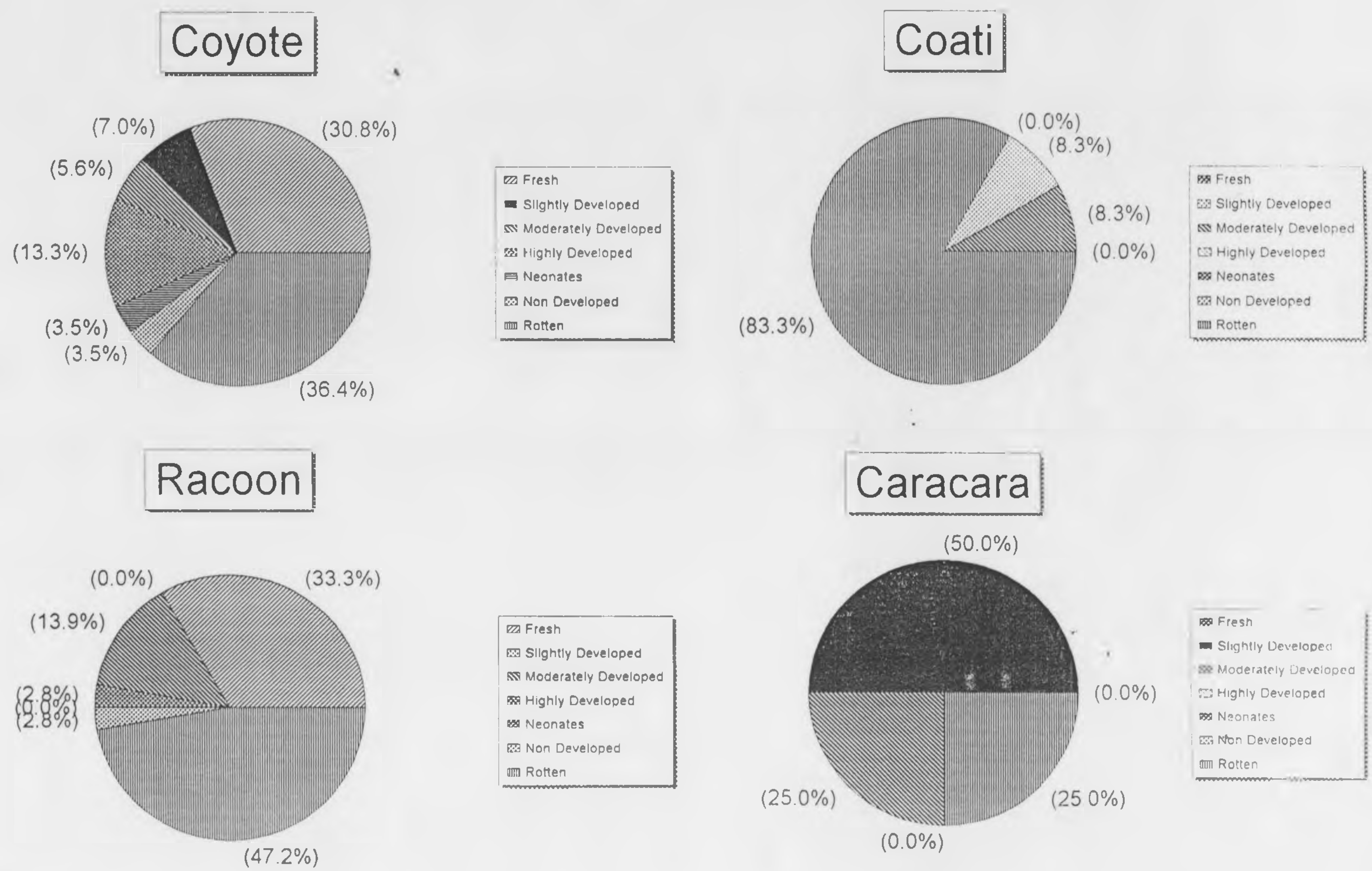


Figure 5

The Stage of Nests Predated Seventeen Days Before and After an Arribada