Biol Invasions (2010) 12:437–439
DOI 10.1007/s10530-009-9466-8

INVASION NOTE

Invasive migration of a mainland rodent to santa catalina island and its effect on the endemic species *Peromyscus slevini*

Sergio Ticul Álvarez-Castañeda · Gustavo Arnaud · Patricia Cortés-Calva · Lia Méndez

Received: 25 March 2009 / Accepted: 31 March 2009 / Published online: 18 April 2009

Abstract Santa Catalina Island has an endemic mouse, *Peromyscus slevini*, which is the only native rodent species on the island. However, specimens of *P. fraterculus* have been recorded on the island. *P. fraterculus* is the most common species of *Peromyscus* off Santa Catalina Island in the Baja California peninsula. The records show the absence of *P. slevini* in the 1990s and an increasing number of *P. fraterculus* during the 2000s. *P. slevini* has recently been collected in 2007. The current situation in Santa Catalina Island shows a strong expansion of *P. fraterculus* and the restriction of *P. slevini* to the canyons. This study confirms for the first time the recent invasion of a peninsular native species in one island on the Gulf of California. *Peromyscus fraterculus* is a better desert adapted species in contrast to *P. slevini*. Under those conditions, in the near future, *P. slevini* could be extinct.

Keywords Endemic · Rodents · *Peromyscus* · Island · Invasion

S. T. Álvarez-Castañeda (✉) · G. Arnaud · P. Cortés-Calva · L. Méndez
Centro de Investigaciones Biológicas del Noroeste (CIBNOR), Mar Bermejo 195, Apdo. Postal 128, 23000 La Paz, Baja California Sur, Mexico
e-mail: sticul@cibnor.mx

Northwestern Mexico has the greatest number of extinct mammalian taxa in Mexico (Mellink 1992; Álvarez-Castañeda 1994; Álvarez-Castañeda and Cortés-Calva 1996; 2002b; Álvarez-Castañeda et al. 2006). The main cause of mammalian extinctions on the islands is the introduction of non-native species, primarily domestic cats (*Felis*) that prey on endemic taxa and rodents (*Mus* and *Rattus*) that compete for space and resources (Álvarez-Castañeda and Ortega-Rubio 2003). However, no instances of extinction of a species through congeneric introductions have been recorded for the islands in the Gulf of California.

Santa Catalina Island has an endemic mouse, *Peromyscus slevini*, which has only been collected on four occasions: in 1921 by Mailliard (1924), 1931 by Burt (1934), 1985 by the Universidad Nacional Autónoma de México, and in 1992 by Hogan et al. (1997). However, 18 surveys were made by different researchers from the Centro de Investigaciones Biológicas del Noroeste in the years 1993–1995, 2000, and 2002–2007. Surveys of the 2000s were made by herpetological groups (Gustavo Arnaud) that focused on the food habits of *Crotalus catalinensis* and a census of the rodents. In these surveys, all the collected rodent specimens were considered *P. fraterculus*, but they noticed two morphotypes by size.

Additional surveys were made in 2006 and 2007 to search for *P. slevini* by trapping in all the habitats of the island. Two groups of rodents in body size and morphology were found. One of the groups (smaller size specimens), of the subgenus *Haplomylomys*, was

identified as *P. fraterculus*, and the second one (larger size specimens), in the subgenus *Peromyscus*, was tentatively identified as *P. slevini*. Our goal is to see if the extension in range of *P. fraterculus* on Santa Catalina Island is affecting the range of the endemic species *P. slevini*.

Surveys of Santa Catalina Island were conducted on more than 17 occasions from 1993 through 2007 at different seasons. (Table 1) The specimens were collected using Sherman live traps (H. B. Sherman Co., Tallahassee, Florida). The lines consisted of 40 traps at 10-min intervals, using rolled oats as bait. Since *P. slevini* is considered threatened only five specimens with this morphology were collected; a large number of others were toe-clipped and released. *P. fraterculus* specimens were collected in different trips in the 1990s. Voucher specimens and tissues are housed in the Centro de Investigaciones Biológicas del Noroeste (CIB).

The number of specimens collected changed with the months and years, with the greatest trap efficiency in October 2005 and the lowest in May 1993 and June 1994. During trapping, data were not recorded to explain the numbers of small (*P. fraterculus*) and large (*P. slevini*) individuals. However, field experiences suggest that the number of small individuals has decreased in recent years, and that of the larger ones has increased. In the early 1990s, only specimens of the small specimens were collected, and in 2007 only the larger ones were found.

The trap lines did not show any marked differences between those used for the small and larger specimens. However, in those years, when the proportion of both species was relatively similar, *P. slevini* was more frequently associated with the bottom of canyons and upland areas; *P. fraterculus* was more frequently found in coastal and open areas.

The introduction of *P. fraterculus* could have taken place on Santa Catalina Island between the last survey in which *P. slevini* specimens were collected in 1992 (Hogan et al. 1997; Smith et al. 2000), before *P. fraterculus* was recorded on the island and before the first collection of *P. fraterculus* in 1995 by our group. In 1993–1994, no rodents of any species were collected on Santa Catalina Island.

At the same time, an El Niño event affected the area. This event showed very unusual winter precipitation in Bahía de Los Angeles (four degrees latitude to the north of Santa Catalina Island) that had a strong effect on the plant and animal communities of the

Table 1 Relationships among the different surveys to Santa Catalina Island, number of collected specimens, number of traps, and efficiency

Date	No. of localities	No. of rodents captured	No. of tramps	Efficiency (%)
May 1993	1	0	80	0
June 1994	1	0	100	0
October 1995	7	15	700	2.1
April 1998	2	5	40	12.5
April 2002	6	182	417	44
August 2002	6	55	350	16
October 2002	2	45	100	45
October 2003	2	14	100	14
July 2004	5	14	250	6
January 2005	2	14	100	14
April 2005	3	43	297	14
June 2005	3	28	297	9
September 2005	3	10	297	3
December 2005	5	33	397	8
May 2006	3	15	75	20
March 2007	2	14	50	28
May 2007	3	30	75	40
September 2007	2	7	50	14
Total		504	2855	18

islands. Plant cover increased from 10 to 160-fold, which was reflected by a large increase in herbivorous species (Polis et al. 1997). In Bahía de Los Angeles, the monitored herbivorous species were insects because no mammals seemed to be present on the islands that were surveyed (Polis et al. 1997). However, this pattern likely applied to herbivorous rodents on the islands in the vicinity. In this case, the population of rodents might have increased in size and reached a high density on the island. Under this scenario, *P. fraterculus* could spread out over the entire island. In 1994, the herbivorous community collapsed, as our trapping survey showed the lowest level of all the surveys. Our hypothesis is that the rodent community on the island collapsed between 1993 and 1994. This response was the result of El Niño (1992) effects in plants and insects, affecting rodent populations.

The presence of widespread haplotypes of *P. fraterculus* on the island showed that only a very small number of specimens were introduced to that island. We cannot distinguish if it occurred in a single event or as a consequence of the use of the island by human activities that could have changed the fauna of the island (Álvarez-Castañeda et al. 2006).

Burt's field notes of 1934 indicate that *P. slevini* were very numerous and that they were even out during the day. They were captured in the bottom of a draw with sandy soil (Álvarez-Castañeda and Cortés-Calva 2002a). In the surveys from 1994 through 1998, specimens of *Peromyscus* were not very common, and in the best collecting season, only 12.5% of the traps were successful. No specimens of *P. slevini* were collected in those years; all the specimens were *P. fraterculus*. The last collection of *P. slevini* specimens on Santa Catalina Island was in 1992 (Hogan et al. 1997; Smith et al. 2000) and the first collection of *P. fraterculus* was in 1994.

The probable invasion to the island by *P. fraterculus* was in the beginning of the 1990s and it spread throughout the island. The immediate effect of this was a reduction in the *P. slevini* population. The most recent surveys show that the population of *P. slevini* is restricted to the canyons and inland areas, and *P. fraterculus* has their highest densities along the coastal and open areas of the island.

Considering the best adaptation of *P. fraterculus* to desert conditions, *P. slevini* could be extinguished in the near future. Slevini's mouse is considered endangered by the Mexican government (SEMARNAT 2002), and a recovery plan has not yet been developed.

Acknowledgments CONACYT (SEMARNAT-2002-E01-0193, 23423, 80455 grants) for its financial support.

References

Álvarez-Castañeda ST (1994) Current status of the rice rat *Oryzomys couesi peninsularis*. Southwest Nat 39:99–100. doi:10.2307/3672202

Álvarez-Castañeda ST, Cortés-Calva P (1996) Anthropogenic extinction of the endemic deer mouse, *Peromyscus maniculatus cineritius*, on San Roque Island, Baja California Sur, Mexico. Southwest Nat 41:99–100

Álvarez-Castañeda ST, Cortés-Calva P (2002a) *Peromyscus slevini*. Mamm Species 705:1–2. doi:10.1644/1545-1410(2002)705<0001:PS>2.0.CO;2

Álvarez-Castañeda ST, Cortés-Calva P (2002b) Extirpation of Bailey's pocket mouse, *Chaetodipus baileyi fornicatus* (Heteromyidae: Mammalia), from Isla Montserrat, Baja California Sur, Mexico. West N Am Nat 62:196–197

Álvarez-Castañeda ST, Ortega-Rubio A (2003) Current status of rodents on islands in the Gulf of California. Conserv Biol 109:157–163. doi:10.1016/S0006-3207(02)00121-0

Álvarez-Castañeda ST, Cortés-Calva P, Méndez L, Ortega-Rubio A (2006) Sea of Cortes island development call for mitigation. BioSciences 56:825–829. doi:10.1641/0006-3568(2006)56[825:DITSOC]2.0.CO;2

Burt WH (1934) Subgeneric allocation of the white-footed mouse *Peromyscus slevini*, from the Gulf of California, Mexico. J Mammal 15:159–160. doi:10.2307/1373985

Hogan KM, Davis SK, Greenbaum IF (1997) Mitochondrial-DNA analysis of the systematic relationships within the *Peromyscus maniculatus* species group. J Mammal 78:733–743. doi:10.2307/1382932

Mailliard J (1924) A new deer mouse (*Peromyscus slevini*) from the Gulf of California. Proc Calif Acad Sci 12:1219–1222

Mellink E (1992) Status de los heterómidos y cricétidos endémicos del estado de Baja California. Comunicaciones académicas, serie ecología, Centro de Investigaciones Científicas y de Educación Superior de Ensenada, Ensenada, B.C., Mexico 2:1–10

Polis GA, Hurd SD, Jackson CT, Sánchez Piñero F (1997) El Niño effects on the dynamics and control of an island ecosystem in the Gulf of California. Ecology 78:1884–1897

SEMARNAT (2002) Proyecto de Norma Oficial Mexicana Proy-NOM-059-Ecol-2001 Protección Ambiental Especies nativas de México de flora y fauna silvestres-categorías de riesgo y especificaciones para su inclusión, exclusión o cambio Lista de especies en riesgo 6 de marzo 2002 Diario Oficial de la Federación, Mexico City

Smith LR, Hale DW, Greenbaum IF (2000) Systematic implications of chromosomal data from two insular species of *Peromyscus* from the Gulf of California. J Hered 91:162–165. doi:10.1093/jhered/91.2.162