2) En la Zona del Bosque Siempre Verde (250-800 m), el introducido guayabo (*Psidium guajava*) mostró un 90% de mortalidad del dosel, pero una alta capacidad de retoñar de la base. La densa cobertura de la enredadera *Ipomoea alba* inhibe en grandes áreas efectivamente el reestablecimiento del guayabo, lo que podría beneficiar plantaciones de árboles nativos. En menores altitudes, la probablemente introducida *Trema micrantha* establece bosques densos (0.5 arboles/m^2) pudiendo posiblemente reprimir el guayabo, y/o volverse una nueva plaga. *Scalesia cordata* mostró una numerosa regeneración inicial, hasta que plagas produjeron una alta mortalidad.

3) En el Bosque Semideciduo (80-250 m), vegetaciones afectadas por fuegos rápidos limitados al sotobosque, regeneraron dentro de 2 años; pero áreas con alta abundancia de jaboncillo (*Sapindus*) quemaron completamente y la regeneración demorará muchos años.

Los incendios producen cambios vegetacionales a largo plazo y ayudan a la dispersión de plantas introducidas. Un alto número de plantas raras mostró ninguna o sólo baja regeneración dentro de 2 años.

Varias medidas para prevenir y controlar incendios son indispensables.

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DISTRIBUTION AND FLIGHT ACTIVITY OF CARABID BEETLES GENUS *TACHYS* IN THE GALAPAGOS ARCHIPELAGO

By: Konjev Desender, Leon Baert, and Jean-Pierre Maelfait

ABSTRACT

This preliminary report summarizes the results of recent studies of the carabid beetles belonging to the genus *Tachys* in Galápagos. In addition to the two species previously known to occur in the islands, we discovered a third as yet unidentified species on the islands of Santa Cruz and Rábida.

INTRODUCTION

Carabid beetles belong to a very species-rich beetle family, with worldwide occurrence. Recent estimates of as many as 50,000 species have been proposed (N. Stork, pers. comm.). Nevertheless, many carabids can be characterized by a more or less similar body form, whereas macromorphological adaptations would only have occurred to a lesser degree during their evolutionary history. Despite this similarity, carabids are found in virtually all terrestrial ecosystems. Many species show a very high degree of specialization in their habitat preference, which seems mainly a consequence of ecophysiological adaptations, i.e., adaptations to different microclimatological conditions. Most species are known to be carnivorous and show a pronounced soil surface activity, at least during their reproductive season. Ground beetles show much variation in their ability to disperse, making them an excellent group for evolutionary and biogegraphic studies.

Insects, and terrestrial invertebrates in general, are among the least studied organisms from the Galápagos Archipelago. The ecological knowledge of insects is especially sparse. The carabid beetles of the genus *Tachys* have been studied (Van Dyke 1953; Linsley and Usinger 1966; Reichardt 1976; Franz 1985), but few ecological data exist for these organisms (Reichardt 1976). The lack of ecological observations for these beetles may stem in part from their small size. Adults attain a length of only 2-3 mm.

Until now only two species of *Tachys* have been recorded from the Archipelago. *Tachys beebei* Mutchler 1925 was described as a species endemic to the Galápagos, but was subsequently found to be synonymous with a previously named species, *T. vittiger* LeConte 1851, which is widespread along the western coast of the Americas (Erwin 1974). Within Galápagos, this species, now known as *T. vittiger*, has been collected using light traps on the islands of Baltra, Seymour, Santa Cruz, and Isabela (cf., Reichardt 1976). *Tachys erwini* Reichardt 1976 is endemic to the islands and is most closely related to *T. vittiger*. It is known from Fernandina and Volcán Darwin on Isabela. Little is known about the ecology of this species.

METHODS

During 1982 and subsequently in 1986, we visited the Galápagos to sample different islands for their beetle and spider faunas. Our main purpose was to contribute to the understanding of the distribution, adaptive radiation, and role of dispersal in the speciation of carabid beetles. As a preliminary step we had to consider problems of identification and taxonomy of these small organisms. During our visit in 1986, we noted abundant insect life at many sites, probably due to the heavy rains in previous months. Besides hand collecting in which we recorded capture success per unit time, we employed light traps which attracted insects to sampling stations. We also studied carabid beetles collected during previous expeditions (previously unpublished data: S. Jacquemart 1974; I. Schatz 1985).

Our samples were identified by means of the available scientific literature and reference material of the two species already known from Galápagos and especially using specimens from the Leleup Expedition deposited in the IRSNB, Brussels (Basilewsky 1968; Reichardt 1976). Table 1 summarizes all new data obtained in our study, including those from the Jacquemart and Schatz expeditions.

RESULTS

The Species and Their Distribution.-- *Tachys vittiger* and *T. erwini* are both easily recognized by the two large pale spots on both of the elytra (the hard winglike structures that cover the functional wings) and the microsculpture (pattern of sculpture only visible at higher magnification) of a very fine mesh on the elytra. The latter species is somewhat larger, and differs in the shape of midbody, especially by having less pronounced posterior angles of the pronotum.

A third species was encountered (Fig. 1) which can be distinguished from the other species by the following combination of characters: smaller in size than *T. vittiger* (mean total length of 2.015 mm versus 2.163 mm for males and 2.039 mm versus 2.282 mm for females), the presence of coarse isodiametric microsculpture evident on the elytra; head, pronotum, and elytra brownish-black without paler spots, the sides of pronotum and elytra only somewhat paler; appendages pale, except femora and penultimate segment of palp somewhat darker. We do not know yet whether this species is known from the continent or elsewhere. Further study is planned to determine if this species is new to science or is instead a species known from elsewhere but not previously known from Galápagos.

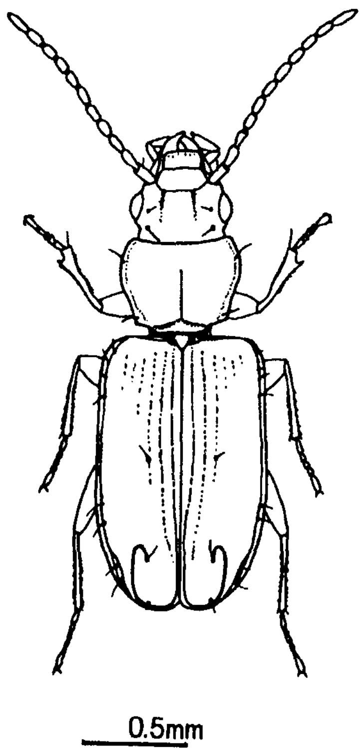

Figure 1. Dorsal view of *Tachys sp.*, an unidentified species only recently discovered in Galápagos. Vista dorsal de *Tachys sp.*, una especie recientemente descubierto en Galápagos y todavia no identifcada.

The distribution of the three species as presently known is summarized in Fig. 2. It is not clear if these beetles have not been adequately sampled in southeastern islands or whether they are not present in this region. Perhaps preferred habitats are rare or absent on these islands. The only sites where we found *T. vittiger* and *Tachys sp.* to be abundant were near lagoons and small ponds with brackish or salty water especially in the coastal zones of the islands. On this basis we suspect that one or more species will be found in the future on Genovesa near the saline crater lake.

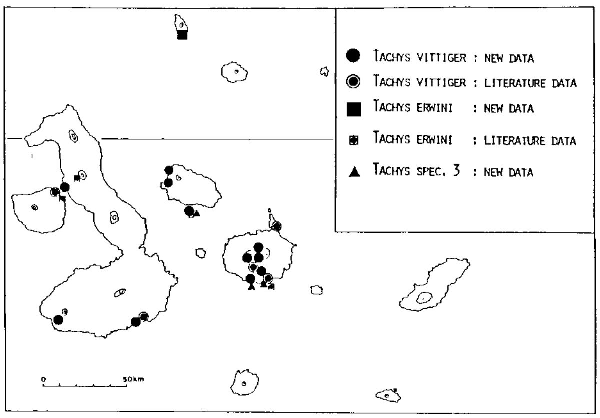

Figure 2. The distribution of *Tachys* species on the Galápagos Islands. La distribución de *Tachys* en las Islas Galápagos.

Flight Activity.--We have noted that all specimens of the three species examined to date by us have possessed large hind wings and had functional indirect flight muscles (these are the main necessary muscles involved in wing beating during flight; in other carabids these muscles can be absent or reduced to a high degree) indicating an ability to fly. We have observed each of the species in flight, but only during nighttime hours. Moreover, we observed that high numbers of beetles could be attracted to a light after heavy rain showers. At least during the warm season, beetles may avoid flight during the day due to the high temperatures and higher risk of water loss in warm dry air. On several occasions when flight was observed, temperatures were recorded to investigate possible threshold reactions of the flight activity (Table 2). Nights with temperatures around 20°C were most productive for capturing beetles in flight; nights with higher temperatures had fewer captures (Table 2). On 1 night the number of beetles caught at a light source in 30 minute intervals was simultaneously compared with the mean temperature of the air over the hours during which beetles were sampled (Fig. 3). On the basis of these data we suggest that flight activity occurs within a narrow range of temperatures at 21-24°C. This conclusion is tentative, because we do not have simultaneous data on humidity of the air, wind speed, and light levels which are other possible factors affecting flight activity of beetles. In any case the attraction of beetles to light proves their ability to orient their flight.

The tendency for insects to lose their flight ability and reduce the distances moved is well-known in island situations, and the flight ability in the diminutive carabid beetles which we found may seem paradoxical in this regard. We propose a simple explanation for this failure to lose flight. The *Tachys* beetles in Galápagos show a high degree of habitat preference for edges of brackish or saline water bodies. They were especially abundant at the borders of all salt marshes explored by us: the lagoon near Villamil and Beagle Crater on Isabela, the lagoons near Playa Espumilla and Mina de Sal on Santiago. and at Turtle Bay on Santa Cruz. The preference for such an unstable habitat that could dry out or be inundated could have serious consequences for the beetles inhabiting the Galápagos. The capacity to fly enables beetles to escape from adverse conditions. A by-product would be the potential for colonization of new areas. The ability to move over large distances by flying contributes to the possibility that one or more of these beetles is likely to occur on each Galápagos island wherever suitable habitats exist. During or after periods with optimal circumstances for flight, small numbers of beetles could be found in other habitats, not just those where the populations are most successful. This could account for observations of *T. vittiger* at higher altitudes in the Transition Zone with *Scalesia* and *Miconia* on Santa Cruz during February 1974 and Volcán Cerro Azul (at 700 m) on Isabela during February 1986. For these species, flight ability seems to be adapted to the instability of their preferred habitats.

CONCLUSIONS

As a consequence of their flight ability, populations of beetles on different islands are not completely isolated and a significant amount of gene flow may occur between relatively distant populations. Adaptive radiation into new or markedly different habitats may be less likely to occur in the face of frequent interisland movements. None of the *Tachys* species is restricted to a single volcano or island within Galápagos. This is in contrast to many other carabid beetles which have limited powers of dispersal and are quite restricted in their distributions within Galápagos (Desender et al., in prep.). Even though *T. vittiger* is the only *Tachys* species known from the South American mainland, the possibility exists that the other two species also occur there.

ACKNOWLEDGMENTS

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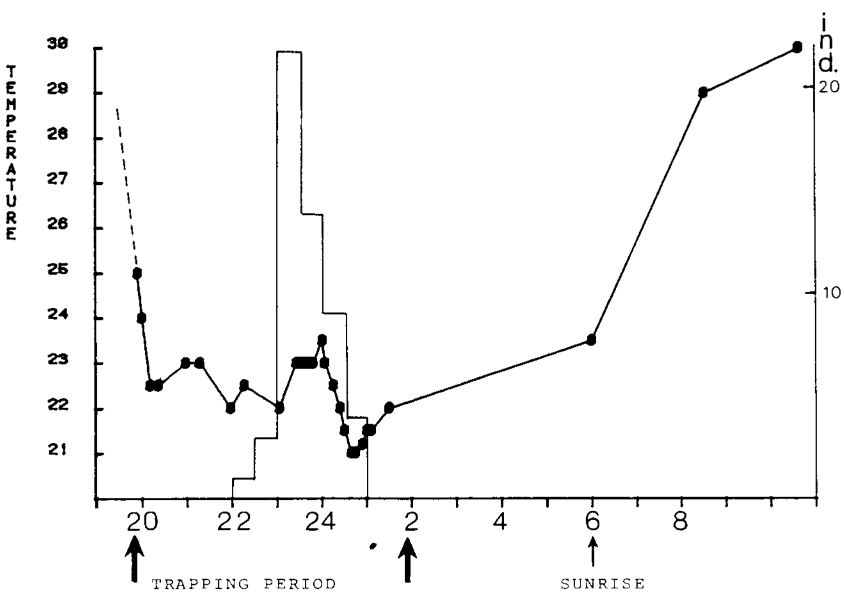

Figure 3. Observed flight activity (vertical bars) of *Tachys vittiger* in relation to mean air temperatures during 1 night in which sampling was conducted from 2000 to 0200. Note the decrease in captures when the air temperature rose above 23°C. Actividad de vuelo (baras verticales) de *Tachys vittiger* en relación al promedio de temperaturas del aire durante una noche entree 2000 y 0200. Se nota una disminución de capturas cuando la temperatura subió arriba de 23°C.

Table 1. New records of *Tachys* species in Galápagos.

Site	Date	Numbers Males/Females	Situation
T. erwini			
Pinta	03 Mar 86	0/ 1	beach zone, near light
T. vittiger			
Isabela	24 Feb 82	8/ 3	Beagle Crater
	21 Feb 86	4/ 4	lagoon, 4 km N Villamil
	21 Feb 86	18/19	lagoon, Villamil
	25 Feb 86	11/11	lagoon, Villamil
	23 Feb 86	0/ 1	Cerro Azul, 700 m
Rábida	09 Mar 86	1/ 2	lagoon
Santa Cruz	15 Jan 74	0/ 1	*Miconia* zone
	07 Feb 74	0/ 1	transition zone
	09 Feb 74	0/ 2	northern slope
	15 Feb 74	1/ 0	top of island
	20 Feb 85	1/ 0	Puerto Ayora
	28 Feb 86	1/12	Darwin Station, near light
	01 Mar 86	11/17	Darwin Station, near light
	02 Mar 86	0/ 1	Darwin Station, near light
	29 Mar 86	21/26	Darwin Station, near light
	14 Mar 86	18/27	Bahía Tortuga, near light
	15 Mar 86	14/20	Bahía Tortuga
Santiago	08 Mar 86	25/35	Mina de Sal
	08 Mar 86	18/16	Playa Espumilla lagoons
T. sp.			
Rábida	09 Mar 86	0/ 1	lagoon
Santa Cruz	15 Mar 86	5/ 5	Bahía Tortuga
	29 Mar 86	0/ 1	Darwin Station, near light

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Table 2. Details of flight activity observed relative to ambient air temperatures. *Specimens in this sample were not sexed.

Date	Site	Period	Temperature Range (°C)	Catch Success Males/Females
19 Mar 86	Pinta	1800-2200	23-30	*T. erwini*, 0/1
21 Mar 86	Pinta	2030-2215	24.5-27	none
28 Feb 86	Darwin Station	2200-2400	24	*T. vittiger*, 11/12
16 Mar 86	Darwin Station	1900-2230	27-28.5	none
29 Mar 86	Darwin Station	2000-0200	21-25	*T. vittiger*, 53*; *T. sp.*, 0/1
14 Mar 86	Bahía Tortuga	2030-2130	24.5-26	*T. vittiger*, 10/19
14 Mar 86	Bahía Tortuga	2130-2230	24.5-25.5	*T. vittiger*, 8/8

REVIEW: FUR SEALS, MATERNAL STRATEGIES ON LAND AND AT SEA

Edited By: Roger L. Gentry and Gerald L. Kooyman

Published 1986, 344 pages, with illustrations. Princeton University Press, 3175 Princeton Pike, Lawrenceville, New Jersey 08648, USA

Reviewed By: Hendrick N. Hoeck

In 1986 two outstanding books on Galápagos species were published by Princeton University Press. One is Peter Grant's *Ecology and Evolution of Darwin's Finches* (reviewed elsewhere in this issue) and the other, which is reviewed here, is *Fur Seals, Maternal Strategies on Land and at Sea* in which Fritz Trillmich and his associates present in five chapters the results of their 10 years of research on the behavioral ecology of Galápagos fur seals and sea lions.

In mammals, the females bear almost all the cost of rearing the young. The long gestation and postnatal period up to weaning is energetically very costly. The mother/offspring group is therefore the key unit for understanding the social organization in mammals.

The overall allocation of maternal energy resources can be divided into several categories such as foraging and travel costs, energy spent for avoiding predators, energy loss due to parasites and diseases, and finally milk production and maintenance metabolism. The pattern of energy allocation to these categories has evolved in response to environmental pressures balanced against physiological limitations.

The book tells the fascinating story of how females of six different species of Otariids, living in Galápagos under tropical conditions and in the Arctic and Antarctic under subpolar conditions, manage to raise a maximum number of offspring. Fourteen scientists (all experts and some with years of field experience) give a detailed account of the behavioral ecology of Northern, Antarctic, South African, South American, and Galápagos fur seals and Galápagos sea lions.

Of the 15 chapters, the first gives an overview of the evolutionary history of the species studied and a brief description of their systematics, distribution, and biology. The second chapter deals with methods. Chapters 3, 6, 8, 10, 11, and 13 describe the attendance behavior of each species, while Chapters 4, 5, 7, 9, 10, 12, and 14 describe the feeding and diving behavior of the six species and the free ranging energetics of the Northern fur seals. In the last and most important chapter, nine authors integrate the results and draw conclusions.

The Northern fur seal and the Antarctic fur seal occur in the subpolar regions where there are extreme cold temperatures but predictable seasonal changes. In contrast, the Galápagos fur seal and sea lion live on the Equator, where the seasonal changes are less profound but are highly unpredictable. Between these environmental extremes a fur seal mother has to adapt in order to produce a maximum number of young. The different options and strategies that fur seal females use are presented.