IS THE ENDEMIC GALÁPAGOS TIGER BEETLE THREATENED WITH EXTINCTION?

Fabio Cassola, Lázaro Roque-Albelo, and Konjev Desender

The Galápagos Islands have long been known to be the home of just one tiger beetle species, the endemic *Cicindela galapagoensis* (Coleoptera, Cicindelidae), first mentioned by Walther Horn in 1915. It was formally described in 1920 based on specimens collected in 1906 by F.X. Williams at Banks Bay, Isabela Island (Horn 1926, 1936, 1938: pl. 84, fig. 9). In 1938 Mutchler described *Cicindela vonhageni* based on a small sample collected by H. von Hagen at Tortuga Bay, Santa Cruz Island (Van Dyke 1953). Furthermore, a *galapagoensis* subspecies, *discolorata,* was described by Mandl (1967a) from a single male specimen collected in 1963 at Genovesa Island (Linsley 1977). Reichardt (1976) synonymized both forms under *galapagoensis* on the basis of two larger samples collected in 1964-65 by N. and J. Leleup on Santa Cruz and Floreana islands. He showed *discolorata* to completely overlap with *vonhageni,* and *vonhageni* to actually be a *galapagoensis* form with fully testaceous elytra, falling within the range of *galapagoensis.*

To date, the Galápagos tiger beetle has been collected from the following islands: Isabela (Banks Bay [type locality]: Horn 1920, Desender *et al.* 1989, 1990, 1992a fig. 2; Playa Tortuga Negra: Desender *et al.* 1992a fig. 2); Fernandina (Cape Hammond: Desender *et al.* 1990, 1992a fig. 2; Punta Espinosa); Santa Cruz (Tortuga Bay [type locality of *C. vonhageni*]: Mutchler 1938, Reichardt 1976, Desender *et al.* 1989; Academy Bay and Darwin Station: Reichardt 1976, Desender *et al.* 1989, 1990; North Coast, Playa Bachas: Desender *et al.* 1990 fig. 1, 1992a fig. 2, 1998 (unpublished data)); San Cristóbal (Sappho Cove, 1996: Desender, Baert, and Verdyck, unpublished); Genovesa (Darwin Bay (Mandl 1967a, Desender *et al.* 1990, 1992a fig. 2)); Marchena (Playa Negra: Desender *et al.* 1990 fig. 1, 1992a fig. 2; 2000, unpublished data); and Floreana (Black Beach: Reichardt 1976, Desender *et al.* 1989, 1992a fig. 2; Punta Cormoran: Desender *et al.* 1989, 1992a fig. 2).

Until now, all records refer to night collecting at light-traps. Indeed, *C. galapagoensis,* unlike most tiger beetles, has never been observed active during the day, not even at sites where it has on numerous occasions been collected at night, such as salt tidal marshes and mud flats near lagoons. This could be a special adaptation of the Galápagos species, in relation to extreme conditions during daytime and/or the reduced daytime activity of potential prey.

The taxonomic classification of this group is still not clear. The old-fashioned, nearly cosmopolitan, biogeographically meaningless, giant genus *Cicindela* Linné, 1758 [type-species: *C. campestris* Linné, 1758, from the Palaearctic region] was long ago split into many distinct genera by Rivalier (1954). This author ascribed most Mexican and Central American species to his genus *Cicindelidia.* Reichardt (1976) demonstrated that *galapagoensis* is related to *Cicindelidia* because of the typical ear-like conformation of the inner sac of the male genitalia. However, Wiesner (1992) instead arranged both *galapagoensis* and *vonhageni* as two distinct species, in the genus *Habroscelimorpha* Doktouroff, 1883 [type-species: *H. dorsalis* (Dejean, 1826), from coastal eastern United States], between the Central American species *H. schwarzi* (W. Horn, 1923) and *H. boops* (Dejean, 1831). This association was recently maintained by Pearson *et al.* (1999).

An attempt to collect further fresh *galapagoensis* specimens at Tortuga Bay on 18 April 2000 (F. Cassola and L. Roque-Albelo) unfortunately failed. However, we examined a male *galapagoensis* specimen from Genovesa, collected in March 1988, and this species proved to belong to the genus *Cicindelidia,* despite some unusual characteristics such as the large protruding eyes, the poorly microserrated elytra, and the relatively long legs. The same conclusion was reached after examination of specimens from Floreana and Santa Cruz (K. Desender). More detailed studies are at the moment also performed on Galápagos cicindelid populations, including biometrics, karyotyping, and genetic investigations (K. Desender and co-workers). The results of these ongoing studies may have taxonomic implications, but will certainly be important for conservation purposes.

Desender *et al.* (1992 a, b) reported the recent arrival to Santa Cruz Island of another tiger beetle species, *Cicindelidia trifasciata* (Fabricius, 1781). This is a common, widespread, mainly coastal American species with several subspecies described in the known large distribution range. *Cicindelidia trifasciata* was first collected in Galápagos in 1983, following an extreme El Niño event, and apparently rapidly reached higher numbers than the co-occurring endemic *C. galapagoensis.* At the Tortuga Bay lagoon, light trapping sessions in 1986 and 1991 showed *galapagoensis* to have progressively been reduced to almost insignificant proportions in a very short time span, relative to the ever expanding trifasciata population (Desender *et al.* 1992b).

In 1996 and 1998, the Belgian team observed, respectively, three and four *galapagoensis* and 28 and 30 *trifasciata* in the same area. Two recent daytime visits to the same site (16 and 18 April 2000, F. Cassola and L. Roque) failed to yield any *galapagoensis* at all; however, *trifasciata* occurred in the area by the hundreds (maybe even

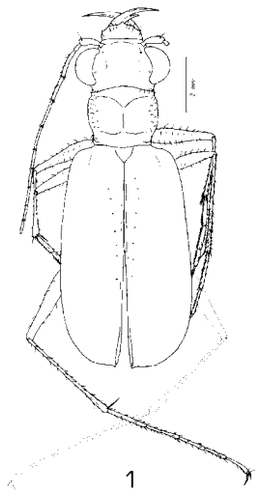

Fig. 1. *Cicindelidia galapagoensis* (W. Horn, 1915), male specimen from Genovesa Island (m. *vonhageni* Mutchler, 1938).

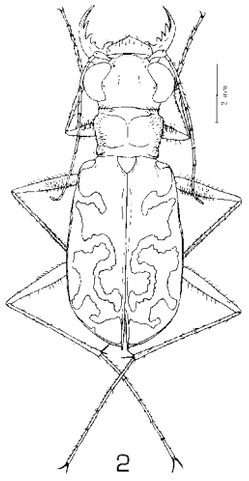

Fig. 2. *Cicindelidia trifasciata* (Fabricius) ssp. *latioresignata* (Mandl, 1967), female specimen from Tortuga Bay, Santa Cruz Island.

thousands). Meanwhile, on 5 April 2000 a night light-trapping session (K. Desender and co-workers) yielded five *galapagoensis* specimens amongst an overwhelmingly large *trifasciata* population (780 individuals counted at traps and partly sampled).

It is evident that *C. trifasciata* has become firmly established on Santa Cruz (Tortuga Bay, surroundings of CDRS, and Playa Bachas: Desender *et al.* 1992b). This species could well be threatening the endemic *C. galapagoensis* with extinction. Probably the two are in some way competitors for prey or range, and, as is often the case, the newcomer, despite its smaller size, could be out-competing the endemic species. In addition, there may be another problem related to the high proportion of *trifasciata* beetles: an observation of a heterospecific pair in copulation (Tortuga Bay, 1991: K. Desender and co-workers) suggests that *galapagoensis* might also be facing confusion or competition in mate choice. To date, *C. galapagoensis* has shown itself to be unable to shift to a different ecological niche, such as the sandy beach of Tortuga Bay, close to the tidal pond where it was once abundant. This habitat type does not support tiger beetles and obviously represents an empty niche.

Desender *et al.* (1992b) concluded that *C. trifasciata* most probably had been introduced accidently to Galápagos. Arrival by natural means through dispersal by flight or rafting on vegetation is less probable, but not completely excluded. The species appeared first on Santa Cruz, the central island most involved in human transport for tourism and local inhabitants. After some 20 years since its arrival in Galápagos, *C. trifasciata* seems still restricted to Santa Cruz in its occurrence.

Peck and Kukalova-Peck (1990) estimated that in order to explain the recent number of beetle species in Galápagos, one succesful natural colonization event had to take place each 10,000 years during the past 3 million years (or, for ground and tiger beetles, one event in about 100,000 years). The numerous recent observations of other species new to Galápagos, therefore, most probably are of human-mediated introductions.

C. trifasciata is known to be highly vagile. It is readily attracted to lights, actively flying to them at night. For instance, it has been collected on oil platforms up to 160km offshore (Graves 1981, 1982). *C. trifasciata* was also able to reach the Revillagigedo Islands in the Pacific Ocean west of Mexico (Cazier 1954), and could have arrived in Galápagos by the same mechanism. It is easy to suppose that individuals attracted to ships' lights in harbors at night could well have made the whole 3-7 days cruise to the Galápagos Islands as well. Given its habits, this species is likely to use this means of dispersal and transport again in the future, to colonize new habitats in the archipelago, thus threatening and displacing other *galapagoensis* populations.

This supposition seems to be strengthened by the fact that the *C. trifasciata* population which has established itself at Tortuga Bay does not appear to belong to the Central American subspecies (*ascendens* LeConte, 1851), but rather to ssp. *latioresignata* (Mandl, 1967), described from northern Peru (Mandl 1967b, 1975) and known to occur commonly in the Guayaquil area as well, thus suggesting an Ecuadorian coastal origin. Because Galápagos material of *trifasciata* has been collected and fixed for genetic studies (Desender and co-workers), it might be possible in the future to trace even more exactly the origin of these beetles on the mainland.

The present situation poses a difficult conservation dilemma. If *C. trifasciata* has colonized the Galápagos naturally, a campaign of eradication would be precluded by the rules of the Galápagos National Park Service

(GNPS). This would hold true even if *C. trifasciata* eliminates *C. galapagoensis*. If, on the other hand, *C. trifasciata* has been introduced by humans, its attempted eradication would be both legal and desirable.

Unfortunately, we cannot yet prove either scenario, although circumstantial evidence points to the latter possibility. It is therefore necessary for entomologists to study this problem in further detail in order to be able to advise the GNPS if and how to control *C. trifasciata*. It seems most probable that steps should be taken to protect the endemic *C. galapagoensis* from extinction.

One such urgent measure is related to another problem facing *C. galapagoensis*. During recent visits (K. Desender and co-workers) to Genovesa, we unfortunately failed to observe any beetles. Apparently the inland part of the small beach at Darwin Bay is now part of the tourist trail. A highly isolated population of *C. galapagoensis* occurred on this site until at least 1988, when the tourist trail did not cross the area. The site is now trampled daily by many visitors. *Cicindelid* larvae live in burrows in humid bare sand or mud and easily suffer from excessive trampling, eventually leading to population extinction.

It is not known whether the species might still be surviving on Genovesa, possibly along one of the few other beaches. A first and urgent measure to protect the Galápagos tiger beetle would be to institute the complete protection of population sites from trampling by tourists, in conjunction with monitoring their present distribution.

ACKNOWLEDGEMENTS

Germania Estevez substantially helped the Belgian team during its recent stay in Galápagos. We also thank Charlotte Causton, Charles Covell, and Robert Bensted-Smith for reviewing the manuscript.

LITERATURE CITED

Cazier, M.A. 1954. A review of the Mexican tiger beetles of the genus *Cicindela* (Coleoptera, Cicindelidae). Bulletin of the American Museum of Natural History 103: 227-310.

Desender, K., L. Baert, and J.-P. Maelfait. 1989. Contribution to the knowledge of the Carabid beetles of Galápagos (Ecuador). Bulletin de l'Institut Royal des Sciences Naturelles de Belgique (Entomologie) 58: 55-65.

Desender, K., L. Baert, and J.-P. Maelfait. 1990. Carabid beetles (Coleoptera, Carabidae) of Galápagos (Ecuador) collected during the Belgian 1988-expedition. Bulletin de l'Institut Royal des Sciences Naturelles de Belgique (Entomologie) 60: 49-54.

Desender, K., L. Baert, and J.-P. Maelfait. 1992a. Distribution and speciation of carabid beetles in the Galápagos Archipelago (Ecuador). Bulletin de l'Institut Royal des Sciences Naturelles de Belgique (Entomologie) 62: 57-65.

Desender, K., L. Baert, and J.-P. Maelfait. 1992b. El Niño events and the establishment of ground beetles in the Galápagos Archipelago. Bulletin de l'Institut Royal des Sciences Naturelles de Belgique (Entomologie) 62: 67-74.

Graves, R.C. 1981. Offshore flight in *Cicindela trifasciata*. Cicindela 13: 45-47.

Graves, R.C. 1982. Another record of offshore flight in *Cicindela trifasciata*. Cicindela 14: 18.

Horn, W. 1915. Coleoptera, Fam. Carabidae, Subfam. Cicindelinae. In P. Wytsman, ed., Genera Insectorum, 82C: 209-487, pl. 16-23.

Horn, W. 1920. Cicindelinen-Studien aus dem schwedischen Reichsmuseum nebst einigen Bemerkungen neuer Arten, etc. III. Einige Neubeschreibungen aussereuropäischer Formen. Atrkiv för Zoologi 13 (11): 16-21.

Horn, W. 1926. Carabidae: Cicindelinae. In W. Junk, ed., Coleopterurm Catalogus, Pars 86. Berlin, 1-345.

Horn, W. 1936. Check list of the Cicindelidae of Oceania. Bernice P. Bishop Museum Occasional Papers 12 (6): 1-11.

Horn, W. 1938. 2000 Zeichnungen von Cicindelinae. Entomologische Beihefte aus Berlin-Dahlem, Berlin, 5: 1-71 + 90 Taf.

Linsley, E. G. 1977. Insects of the Galápagos (Supplement). Occasional Papers of the California Academy of Sciences 125: 1-50.

Mandl, K. 1967a. Neue Cicindeliden-Formen in der Sammlung des Museums G. Frey, Tutzing (Col.). Entomologischen Arbeiten aus dem Museum G. Frey, Tutzing 18: 384-387.

Mandl, K. 1967b. Zweiter Beitrag zur Kenntnis der Cicindeliden-Fauna von Peru (Col.). Entomologischen Arbeiten aus dem Museum G. Frey, Tutzing 18: 432-439.

Mandl, K. 1975. Neue Cicindelidae-Formen aus Südamerika (Coleoptera). Über *Cicindela trifasciata peruviana* Laporte de Castelnau und Beschreibung einer neuen Rasse: *microsoma*. Zeitschrift der Arbeitsgemeinschaft sterreichischen Entomologen 26: 16-19.

Mutchler, A.J. 1938. Coleoptera from the Galápagos Islands. American Museum Novitates 981: 1-19.

Pearson, D.L., J. Buestán, and R. Navarrete. 1999. The tiger beetles of Ecuador: their identification, distribution and natural history (Coleoptera: Cicindelidae). Contributions on Entomology, International 3: 187-315.

Peck, S. B. and J. Kukalova-Peck. 1990. Origin and biogeography of the beetles (Coleoptera) of the Galápagos Archipelago, Ecuador. Canadian Journal of Zoology 68: 1617-1638.

Reichardt, H. 1976. A contribution to the knowledge of the Carabidae of the Galápagos Islands (Coleoptera). In N. and J. Leleup, eds., Mission zoologique belge aux îles Galápagos et en Ecuador, Résultats scientifiques, 3rd part, .pp. 179-222, Koninklijk Museum voor Midden-Afrika, Tervuren.

Rivalier, É. 1954. Démembrement du genre *Cicindela* Linné. II. Faune américaine. Revue française d'Entomologie 21: 249-268.

Van Dyke, E.C. 1953. The Coleoptera of the Galápagos Islands. Occasional Papers of the California Academy of Sciences 22: 1-181.

Wiesner, J. 1992. Verzeichnis der Sandlaufkäfer der Welt. Checklist of the tiger beetles of the world. Verlag Erna Bauer, Keltern. 364 pp.

Fabio Cassola, Via F. Tomassucci 12/20, I-00144 Rome, Italy (Studies on Tiger Beetles, CIX) (e-mail: fabiocassola@skynet.it), Lázaro Roque-Albelo, Charles Darwin Research Station, Galápagos, Ecuador (e-mail: lazaro@fcdarwin.org.ec), and Konjev Desender, Department of Entomology, RBINSc, Vautierstr. 29, B-1000, Brussels, Belgium (e-mail: kdesender @)kbinirsnb.be).