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Aegus chelifer Macleay 1819, an Asian stag beetle (Coleoptera Lucanidae) invading the Seychelles Islands: a threat for endemic saproxylic species?

G.M. Carpaneto [1], L. Bartolozzi [2], P. Mazzei [3], I. Pimpinelli [1] and V. Viglioglia [1]

[1] *Dipartimento di Biologia Ambientale, Università di "Roma Tre", Viale G. Marconi 446, 00146 Roma, Italia* (E-mail: carpanet@uniroma3.it)
[2] *Museo di Storia Naturale, sezione di Zoologia "La Specola", Via Romana 17, 50125 Firenze, Italia* (E-mail: luca.bartolozzi@unifi.it)
[3] *Dynastes srl, Engineering Society (Società di Ingegneria), Via di Torre Morena 48, 00118 Roma, Italia*

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An Indo-Malayan stag beetle, *Aegus chelifer* Macleay 1819, was found for the first time in the Seychelles (Mahé, Praslin, La Digue, Cerf) during four surveys conducted between 2006 and 2009. The species had not been recorded in previous research on the insect fauna of these islands, even in the most recent and comprehensive studies. A. chelifer now appears to be common and widespread in the granitic islands of the archipelago, especially in Mahé, suggesting that a stable population occurs at least on this island. As all the records were made after the 2004 Indian Ocean tsunami, the occurrence of the species in the Seychelles could be explained by transoceanic dispersal from South East Asia by floating tree trunks, due to the action of ocean currents on logs removed from Asia by the tsunami.

key words: Lucanidae, *Aegus*, Seychelles, biological invasion, tropical islands, fauna, biogeography, dispersal.

INTRODUCTION

One of the major threats to biodiversity is represented by alien species, i.e. plant and animals that expand their primary range, favoured by human activities. It is now widely accepted that island ecosystems worldwide are severely affected by these invaders, which alter the interspecific relationships within biological communities and lead to the extinction of indigenous taxa (Sax et al. 2005, Lockwood et al. 2006, Whittaker & Fernandez-Palacios 2007, New 2008). For these reasons, evaluating the current distribution of invasive species and their spread is one of the most important targets of insular biogeography applied to biodiversity conservation.

The Republic of the Seychelles comprises 115 islands in the Western Indian Ocean, including both granitic and coralline islands. The granitic islands are larger and are situated in the northern part of the archipelago. They are the remnants of the Seychelles microcontinent that was isolated following the breakup of Gondwanaland, in the Mesozoic Era, 65-100 million years ago (Stoddart 1984, Gerlach 2008). More specifically, the initial rift was from Madagascar in the Middle Cretaceous, then from India at the end of the Cretaceous (Collier et al. 2004). For this reason, these islands harbour a complex mosaic of components in their species assemblages, due to both vicariant and dispersal events involving Africa, Madagascar and India. The vicariance component includes taxa of ancient origin like the sooglossid frogs (Van der Meijden et al. 2007), while the dispersal component consists of more or less recent immigrant taxa deriving either from Africa or southern Asia, with affinities resulting from the predominant marine currents. The granitic Seychelles islands reach an altitude of around 900 m asl, with high rainfall and high habitat diversity (Gerlach 2008). These factors explain the high biodiversity of their plant and animal communities, which now consist of 850 species of plants and over 2,400 insects. The latter taxonomic group was reported to include some 860 species of the order Coleoptera (506 endemic beetle species, 319 indigenous, 35 introduced) (Gerlach 2008, 2009).

The aim of this paper is to report the recent discovery of a stag beetle species of Asiatic origin, whose immigration to the Seychelles appears to be recent and could represent a threat for endemic saproxylic beetles of these islands.

MATERIAL

Aegus chelifer Macleay 1819

Most adults and larvae were collected from deadwood of broadleaf trees, under bark or fallen tree trunks, in forest patches near human settlements. Specimens from Mahé were found in a stack of firewood in a forest clearing (Figs 1-2). One specimen from La Digue was found in the deadwood of a palm tree. One female collected at Praslin in 2006 and the two females collected at Bel Hombre in 2007 were attracted by mercury vapour lamps.

Only a small percentage of the individuals observed were collected; the species was common and widespread on Mahé and La Digue.

Collection Acronyms:
GC = G. Carpaneto Collection, c/o Museo di Zoologia e Anatomia Com-

parata, Università "Roma Tre", Roma, Italy;
MNHN = Muséum National d'Histoire Naturelle, Paris;
MZUF = Museo di Storia Naturale, Sezione di Zoologia "La Specola", Firenze, Italy;
SB = Stéphane Boucher Collection, Paris;
SMNS = Staatliches Museum für Naturkunde, Stuttgart, Germany;
VV = V. Viglioglia Collection, Roma, Italy.

Collection Data:
Seychelles: Mahé, Bel Hombre, Daniella's (UTM coordinates: 40M 324280 9489450), 20 m asl, 12.X.2007, 2 ♀♀, P. Mazzei leg. (LB); Mahé, Port Glaud (UTM coordinates: 40M 323710 9484840), 10 m asl, 23.VIII.2009, 5 ♂♂, 5 ♀♀, P. Mazzei, I. Pimpinelli, V. Viglioglia leg. (GC, VV); Mahé, Anse Takamaka (UTM coordinates: 40 M 333150 9471920), 25.VIII.2009, 1 ♂, 2 ♀♀, V. Viglioglia leg. (VV).
Cerf Island (3 km east of Mahé), 14-17.VIII.2006, 2 ♀♀, W. Schawaller leg. (SMNS).
Praslin, 12.VIII.2006, 1 ♀, L. Ducci leg. (MZUF).
La Digue, Calou Guesthouse (UTM coordinates: 40M 370870 9518860), 40 m asl, 14-15 VIII.2009, 2♂♂, 1 ♀, P. Mazzei, I. Pimpinelli leg., 3 ♂♂, 2 ♀♀, V. Viglioglia leg. (MZUF, GC, VV).

Fig. 1. — *Aegus chelifer*, male: Seychelles, Mahé, August 2009 (Photo P. Mazzei).

Ile de Nord, north of Silhouette (UTM coordinates: 40M 305395 951438), V.2009, 1 ♂, 2 ♀♀, J.-F. Voisin leg. (SB), 1 ♂, 3 ♀♀, J.-F. Voisin leg. (MNHN).

DISCUSSION

According to the literature (Linell 1897, Kolbe 1910, Benesh 1955, 1960, Maes 1992, Mamet 1992, Gomy 2000, Bartolozzi & Werner 2004, Gerlach 2009, Monte & Bartolozzi 2010), the only stag beetles recorded from the Seychelles were three species of the genus *Figulus* Macleay 1819: *Figulus striatus* (Olivier 1789) occurring at Mahé, Silhouette, Praslin and Aldabra; *F. seychellensis* Scott 1913 occurring at Mahé and Silhouette; *F. magnus* Benesh 1955 occurring at Silhouette, Mahé and Praslin. The first species is widespread on Western Indian Ocean islands, occurring on Madagascar, Seychelles, Réunion, Mauritius and Rodriguez, and Aldabra; the last two species are endemic to the Seychelles (Bartolozzi & Werner 2004; Monte & Bartolozzi 2005, 2010). The genus *Figulus* is widespread and includes about 135 species (6 occurring in Africa, 7 in the Western Indian Ocean islands (including Madagascar), and the remaining ones from Indo-Malayan to Australian regions) (Mizunuma & Nagai 1994; Krajcik 2001, 2003; Maes 2009).

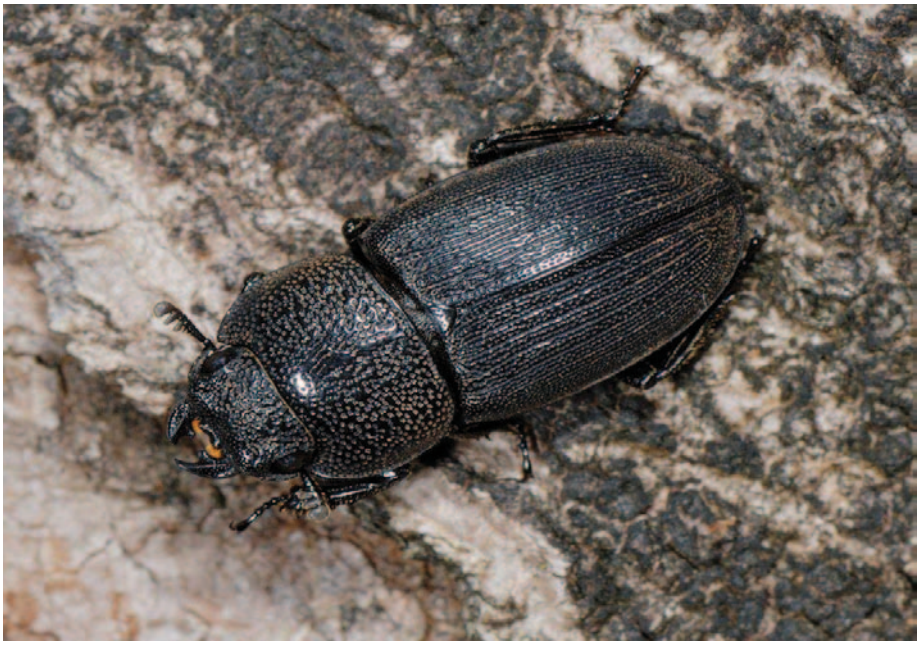

Fig. 2. — *Aegus chelifer*, female: Seychelles, Mahé, October 2007 (Photo P. Mazzei).

During some recent trips to the Seychelles (Mahé, Praslin, Cerf Island and La Digue) by us (PM, IP, VV) and by other colleagues (Laura Ducci, Wolfgang Schawaller), no *Figulus* specimens were found. Indeed, all the stag beetles examined belonged to the Asian species *Aegus chelifer*. These findings appear surprising, if we consider that a comprehensive survey of the biodiversity of the Seychelles islands was conducted in 2000-2005 by the Indian Ocean Biodiversity Assessment project (Gerlach 2008) and produced a series of taxonomic reviews, including an exhaustive volume on Coleoptera (Gerlach 2009).

The genus *Aegus* includes more than 200 species, distributed from India to Australia (most occurring from Indochina to New Guinea) (Mizunuma & Nagai 1994, Krajcik 2003, Maes 2009). *Aegus chelifer* is a common species, widely distributed in southern Asia. The geographic range of this species follows the typical Indo-Malayan distribution pattern, west of Wallace's line (Simpson 1977), including the following territories: India, Bangladesh, Sri Lanka, Andaman and Nicobar islands, Burma, Thailand, Laos, Vietnam, Cambodia, Malayan peninsula, Sumatra and Borneo (Mizunuma & Nagai 1994; Krajcik 2001, 2003; Maes 2009).

The taxonomy of *Aegus chelifer* is rather complex, with several synonyms and subspecies described since 1819. According to Maes (1992), *chelifer* itself is a synonym of the widespread *Aegus acuminatus* (Fabricius 1801), although the same author (Maes 2009) later listed *chelifer* as a valid species. Due to the wide range of distribution and high variability of the species, we believe that only DNA studies on specimens from the different populations will allow clarification of the real status of this taxon. In the same way, molecular analysis could identify from where the Seychelles specimens originated.

The occurrence of *Aegus chelifer* on different Seychelles islands, the finding of both larvae and pupae, the large number of specimens collected (especially in Mahé) without any great search effort, and the aggregation rate of the individuals suggest that this species is now firmly established in the Seychelles. The colonizers probably found optimal conditions and resources, not very different from those in their primary range, i.e. Sri Lanka, the Andaman Islands, Malaysia and Sumatra. Cases of deliberate or accidental anthropogenic introduction are unusual for saproxylic beetles because decaying wood is neither a commercial item nor a commonly handled material on ships. The unique dispersal modality for these insects to islands may be hollow trees uprooted and set adrift by marine currents, mainly after natural catastrophes (e.g. tsunamis, hurricanes). The 2004 Indian Ocean earthquake, which occurred on December 26, 2004, with an epicentre off the west coast of Sumatra, caused a series of devastating tsunamis (Lay et al. 2004). We suggest that the occurrence of *Aegus chelifer* in the Seychelles, detected after the above-mentioned earthquake, may be due to a very recent dispersal event in consequence of the high number of floating tree trunks uprooted by tsunami waves from coastal forests of South East Asia and then carried westward by the South Equatorial Current (Indian Ocean Subtropical Gyre) (Hastenrath 1991).

The larger body size of both adult and larvae of *Aegus* species with respect to *Figulus* species, the wide distribution of the former in the Seychelles, and the lack of the latter in our collections led us to suggest that the former (recent invader) could be a dangerous competitor to the latter indigenous and endemic species.

Indeed, we expect that *Aegus* larvae will consume most of the rare deadwood food resource in the islands, bringing *Figulus* to extinction.

Ecological studies on stag beetles should be carried out in the archipelago with the following objectives:

(1) checking for the presence of *Aegus chelifer* on other Seychelles islands;

(2) checking for *Aegus* specimens collected in the Seychelles before September 2004, to falsify the tsunami hypothesis;

(3) investigating the occurrence of other Asiatic taxa (animals and plants) collected in the Seychelles after December 2004, to strengthen the tsunami hypothesis;

(4) mapping populations of stag beetles (both *Aegus* and *Figulus*) and monitoring their status;

(5) detecting competition for resources among indigenous and introduced species;

(6) assessing the extinction risk for the two endemic species of *Figulus* and developing an action plan for their conservation.

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REFERENCES

Bartolozzi L. & Monte C. 2005. Review of *Figulus sublaevis* (Palisot de Beauvois, 1805) and *F. anthracinus* Klug, 1833 (Coleoptera: Lucanidae). *Koleopterologische Rundschau* 75: 337-348.

Bartolozzi L. & Werner K. 2004. Illustrated catalogue of the Lucanidae from Africa and Madagascar. *Hradec Kralove, Czech Republic: Taita Publishers*, 192 pp.

Benesh B. 1955. Some further notes on the stagbeetles, with special reference to Figulinae (Coleoptera, Lucanidae). *Transactions of the American Entomological Society* 81: 59-76.

Benesh B. 1960. Familia Lucanidae. Coleopterorum Catalogus Supplementum 8. *The Hague: W. Junk Publishers*, 178 pp.

Boileau H. 1899. Descriptions sommaires d'*Aegus* nouveaux (Col.). *Bulletin de la Société Entomologique de France* 48: 319-322.

Bomans H.E. 1992. Considérations sur le genre *Aegus* Macleay et descriptions d'espèces nouvelles, 3ème note. *Lambillionea* 92 (2): 179-196.

Collier J.S., Minshull T.A., Kendall J.-M., Whittmarsh R.B., Rümpker G., Joseph P., Samson P., Lane C.I., Sansom V., Vermeesch M., Hammond J., Wookey J., Teanby N., Ryberg M. & Dean S.M. 2004. Rapid continental breakup and microcontinent formation in the Western Indian Ocean. *EOS, Transactions of the American Geophysical Union* 85: 481-496.

Dejean P. 1837. Catalogue des Coléoptères de la collection de M. le Comte Dejean, 3ème ed. *Paris: Méquignon-Marvis Ed.*, XIV + 503 pp.
Gerlach J. 2008. Preliminary conservation status and needs of an oceanic island fauna: the case of Seychelles insects. *Journal of Insect Conservation* 12 (3-4): 293-305.
Gerlach J. 2009. The Coleoptera of the Seychelles islands. *Sofia-Moskow*: *Pensoft Publishers*, 266 pp.
Gomy Y. 2000. Nouvelle liste chorologique des Coléoptères de l'Archipel des Mascareignes. *Société Réunionnaise des Amis du Muséum, St. Denis La Réunion*, 140 pp.
Hastenrath S. 1991. Climate dynamics of the Tropics. *Dordrecht, The Netherlands: Kluwer Academic Publishers*, 488 pp.
Hope F.W. & Westwood J.O. 1845. A catalogue of the Lucanoid Coleoptera in the collection of the Rev. F.W. Hope, M.A., F.R.S. & c., President of the Entomological Society of London, with descriptions of the new species therein contained. *London: Bridgewater Ed.*, 31 pp.
Jakowlew B.E. 1900. Description de quelques nouvelles espèces de la famille des Lucanides. *Horae Societatis Entomologicae Rossicae* 34: 631-642.
Kolbe H.J. 1910. Die Coleopterenfauna der Seychellen. *Mitteilungen aus dem Zoologischen Museum in Berlin* 5: 1-49.
Krajcik M. 2001. Lucanidae of the world. Catalogue — Part I. Checklist of the Stag Beetles of the World (Coleoptera: Lucanidae). *Most, Czech Republic: Milan Krajcik*, 108 pp.
Krajcik M. 2003. Lucanidae of the world. Catalogue — Part II. Encyclopaedia of the Lucanidae (Coleoptera: Lucanidae). *Plzen, Czech Republic: Milan Krajcik*, 197 pp.
Kriesche R. 1921. Zur Kenntnis der Lucaniden. *Archiv für Naturgeschichte (A)* 86 (8) [1920]: 92-107.
Lay T., Kanamori H., Ammon C., Nettles M., Ward S., Aster R., Beck S., Bilek S., Brudzinski M., Butler R., DeShon H., Ekström G., Satake K. & Sipki S. 2005. The great Sumatra-Andaman Earthquake of December 26, 2004. *Science* 308: 1127-1133.
Linell M.L. 1897. On the insects collected by Doctor Abbott on the Seychelles, Aldabra, Glorioso, and Providence islands, with description of nine new species of Coleoptera. *Proceedings of the United States National Museum* 19: 695-706.
Lockwood J., Hoopes M. & Marchetti M. 2007. Invasion ecology. *Oxford: Blackwell Publishing*, 312 pp.
Macleay W.J.M. 1819. Horae Entomologicae: or essay on the annulose animals. 1 (1). *London*: *Bagster Ed.*, XXX + 523 pp.
Maes J.M. 1992. Lista de los Lucanidae (Coleoptera) del Mundo. *Revista Nicaraguense de Entomologia (B)* 22: 61-121.
Maes J.M. 2009. Lucanidae of the World — Genera and Catalogue. Available at http://www.bio-nica.info/Lucanidae/0-Genera.htm [Accessed on 25 September 2009].
Mamet J.-R. 1992. Bibliographie de l'Entomologie des Iles Mascareignes, 1771-1990. *Mauritius Sugar Industry Research Institute, Mauritius*, 318 pp.
Mizunuma T. & Nagai S. 1994. The Lucanid Beetles of the World. *Tokyo*: *Mushi-sha*, 337 pp.
Monte C. & Bartolozzi L. 2005. Revision of the continental African species of *Figulus* Macleay, 1819, with description of *Figulus pseudominor* n. sp. (Coleoptera, Lucanidae). *Entomologia Africana (Hors Série)* 2: 1-24.
Monte C. & Bartolozzi L. 2010. Revision of the African *Figulus* Macleay, 1819 (Coleoptera, Lucanidae). 2: the insular species. *Entomologia Africana (Hors Série)* (in press).

New T.R. 2008. Insect conservation and islands. *Dordrech: The Netherlands*: *Springer,* 252 pp.
Sax D.F., Stachowicz J.J. & Gaines S.D. 2005. Species invasions: Insights into ecology, evolution, and biogeography. *Sunderland, Massachusetts: Sinauer Associates*, 480 pp.
Simpson G.G. 1977. Too many lines; the limits of the Oriental and Australian zoogeographic regions. *Proceedings of the American Philosophical Society* 121 (2): 107-120.
Stoddart D.R. (Edit.) 1984. Biogeography and ecology of the Seychelles islands. *The Hague: W. Junk Publishers*, 691 pp.
Van der Meijden A., Boistel R., Gerlach J., Ohler A., Vences M. & Meyer A., 2007. Molecular phylogenetic evidence for paraphyly of the genus *Sooglossus*, with the description of a new genus of Seychellean frogs. *Biological Journal of the Linnean Society* 91 (3): 347-359.
Waterhouse C.O. 1890. Descriptions of new Pectinicorna Coleoptera. *Annals and Magazine of Natural History* (6) 5: 33-39.
Whittaker R.J. & Fernandez-Palacios J.M. 2007. Island biogeography. Ecology, evolution and conservation 3rd ed. *New York: Oxford University Press*, 416 pp.