Survey of Bioluminescent Coleoptera in the Atlantic Rain Forest of Serra da Paranapiacaba in São Paulo State (Brazil)

Raphael M. Santos¹, Marcelo Nivert Schlindwein² & Vadim R. Viviani¹,³

¹Universidade Federal de São Carlos, Departamento de Física, Química e Matemática, Sorocaba, SP, Brazil.
²Universidade Federal de São Carlos, Departamento de Biologia, Sorocaba, SP, Brazil.
³Corresponding author: Vadim R. Viviani, e-mail: viviani@ufscar.br

SANTOS, R.M., SCHLINDWEIN, M.N., VIVIANI, V.R. Survey of Bioluminescent Coleoptera in the Atlantic Rain Forest of Serra da Paranapiacaba in São Paulo State (Brazil). Biota Neotropica. 16(1): e0045. http://dx.doi.org/10.1590/1676-0611-BN-2015-0045

Abstract: Brazil is the country with the largest number of bioluminescent beetle species in the world. However, estimates suggest that this number could much be higher, since many species remain to be discovered. In this work we made a survey of the species of bioluminescent beetles in Serra de Paranapiacaba – the largest remnant of Atlantic Forest in São Paulo State. The survey was done at Intervales State Park, Carlos Botelho State Park and municipality of Tapirai and the following species were collected: Aspisoma lineatum, Aspisoma physonotum, Aspisoma fenestrata, Cratomorphus beskeyi, Cratomorphus distinctus, Photinus penai, Photinus sp1, Photinus sp9, Ethra aff. maledicta or axilaris, Ethra aff. adicta, Lucidotini incertae sedis, Cladodes flabellicornis, Cladodes demoulini, Amydetes lucernata, Bicellonycha sp9, Bicellonycha ornaticollis, Pyrogaster lunifer, Pyrogaster moestus, Pyrogaster sp2, Pyrogaster sp5, Pyrogaster sp6, Photuris lugubris, Photuris sp1, Photuris sp3, Stenophrixotrix sp1, Brasilierocerus sp1, Pseudophengodes sp1, Hapsodrilus pyrotis, Hypsiophthalmus sp1, Ptsimopsis luculenta, Pyroptesis cincticollis, Pyrearinus candelarius, Pyrearinus micatus, Pyrophorus divergens. Our data show that Serra de Paranapiacaba is the second richest area in São Paulo state, especially in elaterids, with unique species typical of this area and species common to other investigated sites such as the Biological Station of Boracéia (in Salesópolis county) and the urbanized areas in the between Campinas - Sorocaba - São Paulo, originally covered to the Atlantic Rainforest.

Keywords: Lampyridae, Phengodidae, Elateridae, Elateroidea, Staphylinidae, bioluminescence, Fireflies, Atlantic Rainforest.

SANTOS, R.M., SCHLINDWEIN, M.N., VIVIANI, V.R. Levantamento de Coleópteros bioluminescentes na Mata Atlântica da Serra da Paranapiacaba. Biota Neotropica. 16(1): e0045. http://dx.doi.org/10.1590/1676-0611-BN-2015-0045

Resumo: O Brasil é o país que possui o maior número de espécies de coleópteros bioluminescentes no mundo. Entretanto, estimativas sugerem que este número possa ser bem maior, dado que muitas espécies ainda não foram descritas. Neste trabalho foi realizado um levantamento das espécies de coleópteros bioluminescentes em três localidades na Serra da Paranapiacaba – a maior área remanescente contígua de Mata Atlântica no país, com associação ao respectivo habitat. No Parque Estadual Intervales, Parque Estadual Carlos Botelho e Tapirai foram coletadas as seguintes espécies: (Lampyridae) Aspisoma lineatum, Aspisoma physonotum, Aspisoma fenestrata, Cratomorphus beskeyi, Cratomorphus distinctus, Photinus penai, Photinus sp1, Photinus sp9, Ethra aff. maledicta ou axilaris, Ethra aff. adicta, Lucidotini incertae sedis, Cladodes flabellicornis, Cladodes demoulini, Amydetes lucernata, Bicellonycha sp9, Bicellonycha ornaticollis, Pyrogaster lunifer, Pyrogaster moestus, Pyrogaster sp2, Pyrogaster sp5, Pyrogaster sp6, Photuris lugubris, Photuris sp1, Photuris sp3, Stenophrixotrix sp1, Brasilierocerus sp1, Pseudophengodes sp1, Hapsodrilus pyrotis, Hypsiophthalmus sp1, Ptsimopsis luculenta, Pyroptesis cincticollis, Pyrearinus candelarius, Pyrearinus micatus, Pyrophorus divergens. Estes dados mostram que esta constitui a segunda área mais rica em espécies luminescentes do Estado de São Paulo, depois da Est. Biológica de Boracéia, especialmente em elaterídeos, com espécies únicas características destas localidades e espécies comuns às outras áreas investigadas, como da Estação Biológica de Boracéia (Salesópolis, SP) e áreas urbanizadas no triângulo Campinas - Sorocaba - São Paulo, originalmente cobertas por Mata Atlântica.

Palavras-chave: Lampyridae, Phengodidae, Elateridae, Elateroidea, Staphylinidae, vaga-lumes, bioluminescência, mata atlântica.
Introduction

Brazil has the largest diversity of luminescent beetles in the world, about 500 described species, corresponding about 23% of described species in the world (Costa 2000; Viviani et al. 2010). These species are distributed mainly in the three main families of Elateroidea: Lampyridae, Phengodidae and Elateridae. Furthermore, two species of luminescent Staphylinidae were reported (Costa et al. 1986; Rosa 2010). These species are distributed mainly in the following biomes: Atlantic Rainforest, Cerrado (Savannah), Pantanal (Marshes) and Amazon Rainforest. Among these ecosystems, the Atlantic Rainforest is one of the richest and also most threatened ones, currently with only around 7-8% of the original cover or 11.4-16% when considering the the small woods (Ribeiro et al. 2009).

Despite their biodiversity, taxonomic and systematic studies on bioluminescent beetles in Brazil are still scarce. Detailed modern taxonomical studies are found mainly for Elateridae by Costa e collaborators (Costa et al. 1988, Costa 1971a, 1971b; 1972, 1975). However, the families Lampyridae and Phengodidae lack recent reviews and their systematics remains troublesome. Some studies on the biology and ecology were performed for some species of Elateridae (Costa 1975, Costa et al. 1988) and Phengodidae (Costa et al. 1999, Viviani & Bechara 1997). In the family Lampyridae, bionomic studies were done for two semi-aquatic species of Aspisoma spp. (Costa et al. 1988, Viviani 1989), Aspisoma lineatum Gyllenhaal, 1817 (Viviani et al., 2012), some lampryid species of São Paulo State (Viviani 2001) and for Photuris fulvipes Blanchard 1837(Rosa 2007). Recently, the genus Amydetes was revised with the description of several new species (Da Silveira and Mermudes, 2014).

Considering the growing importance of fireflies and bioluminescent beetles as potential environmental indicators (Viviani 2001) and for scientific studies and in biotechnology as source of bioluminescent reagents (Viviani 2007), it is urgent to make biodiversity surveys to aid conservation and bioprospection programs.

The Atlantic Forest is, after the Amazon, the second largest forest type in South America. The last corridor of this forest is located mostly in São Paulo state, being composed of a series of protected areas with more than 17,300 km2 of forests (Galleti Jr et al. 2008). Considering the lack of knowledge about bioluminescent beetles in Brazil, in the nineties, and especially from 2006 we made surveys in the Atlantic rain forest. We already made lists of species occurring near the urban areas of Campinas, Rio Claro, Sorocaba and Votorantim cities in São Paulo State, which were mostly covered by seasonal Atlantic rain forest in the past (Viviani 2001, Viviani et al. 2010) and more recently about the bioluminescent species occurring in the hotspot of Biological Station of Boracéia located in the second largest remnant of Atlantic rain forest of Serra do Mar, along the coastline (Viviani & Santos 2012). In this study we present a first survey made from 2007-2012 in the largest and most preserved remnant of Atlantic rain forest in São Paulo State, which is located along of Serra da Paranapiacaba, including three main investigated sites: (I) Cachoeira do Chá in the municipality of Tapirai at its Northern border; (II) Parque Carlos Botelho in the middle and (III) Parque Intervales in the Southern part.

Materials and Methods

Habitats description. The investigated sites are located in a largest continuous remnant of Atlantic rain forest along the scarp chain Serra da Paranapiacaba, which is a subdomain of the Serra do Mar scarp chain, located about 100 km from the coast between the hydrographic basins: Soroca-Médio Tieté, Paranapanema and Ribeira-Southern Shore. The main kind of forest is dense mountain ombrophyl forest (Fig.1) with the following phytosynromonic divisions: (I) mountain forest located over the mountains which include tall trees; (II) humid forest located between mountains over water bodies, which includes similar vegetation to the former habitat but with the presence of species better adapted to humid environments; (III) marshy areas at the borders of water bodies and streams which display typical grasses, and (IV) open fields surrounding the reservation or along thoroughfares opened in the forest. The following sites were investigated:

Cachoeira do Chá, Tapirai. (24°01’47.50”S - 47°34’29.47”W, 595m asl). This is a trail located along a stream at the Northern border of the large remnant, bordered by the route SP-79 and located 15 km from Tapirai municipality. In this site the mountains display an escarpment ending at Ribeira River Valley.

Carlos Botelho. (24°03’46.48”S - 47°59’30.31”W, 763m asl). This park features a rugged terrain in the upper level followed by escarpment ending at the Ribeira River Valley in the lower part (Fig.1). Located in the north, at higher elevations there is a watershed of Ribeira River Valley Basin and another (Taquaral river) of Paranapanema River Basin. The mountains have dense rain forest (Montana forest), whereas in the lower part of the drive at the southeast, the vegetation is composed mainly by lowland tropical rain forest (Submontana forest). The survey sites within this unit are located near the headquarters, in the Northern part of the Park in the municipality of São Miguel Arcanjo.

Fazenda Intervales. (24°16’12.46”S - 48°25’17.11”W, 826m asl). This site is located on the Serra da Paranapiacaba, and also on the Planalto de Guapiara, with very rough relief cut by headwater streams. The study site in this reserve was located between Guapiara and Ribeirão Grande municipalities. The present forest coverage is characterized as Montana forest as described above and the differential in this area is the geological and geomorphological formation, with many valleys and hills. The investigated areas were all located in the protected area, with the trails in the northwestern part of the Park.

Collecting techniques. The collecting and observations were originally done in 1991 and 1993 at Intervales, and then yearly from 2007-2012. In Intervales, collecting and observations were done in the period of October-April and eventually in July. In Carlos Botelho the observations and collecting were made weekly between July and December from 2007-2010. In Tapirai, observations were done from 2009-2012, with sporadic visits in the same period from November through March.

Adult lampyrids and elaterids were located by their own light at night and collected in flight with entomological net, or in the bushes or in the litterfall, during the period from August to April. They were also collected on the foliage during the day, especially diurnal lampyrids. Luminescent click-beetles and even some lampyrids such as Cratomorphus distinctus Olivier 1895 firefly could also be attracted to green chemiluminescent light sticks. Adult male phengodids were collected, in rare occasions, on soil and on the grass. Firefly larvae were collected on the undergrowth, in litterfall
and soil at night, by the location of their glows (Viviani 2001, Viviani et al. 2010). Phengodid larvae were also collected at night in the soil, in embankments, and eventually on the underbrush by location of their luminescence (Viviani & Bechara 1997).

Identification. Specimens of fireflies and their larvae were identified first by comparison with scientific collection of Professor Viviani at UFSCar, which was previously identified by comparison with the collections of Museu de Zoolo gia da Universidade de Sa˜o Paulo (Sa˜o Paulo, Brazil), Natural History Museum of Paris (France) and British Museum (London, UK). Some species were identified by Dra. S. P. Rosa during her visit at the Natural History Museum of Paris (France). Elateridae species were previously identified by Dra. C. Costa (MZUSP) and Dra. S. P. Rosa. Several lampyrid and phengodid species could not be identified, and were catalogued by the name of the genus followed by a specific number (separated in morph species), according to Viviani & Bechara (1997) and Viviani (2001). The specimens were deposited in the collection in UFSCar under curatorship of V. Viviani.

Figure 1. (Upper panel) Map of São Paulo State showing the investigated sites; (Lower panels) main vegetation types on the study area: (a) Mountain Atlantic Rainforest in the top of hills in Carlos Botelho State Park, here the view of the Submontane Forest in the Ribeira Valey Basin is shown; (b) Humid forest at Carlos Botelho State Park. View of a marshy area along riparian woods in the Taquaral stream; (c) Open field with vegetal species more light tolerant, including grasses at the ground level and creepers at the edge of woods. This image represents a site with occurrence of Bicellonycha sp8 – a brazilian synchronous firefly – in Intervales State Park.

Figure 2. Number of bioluminescent Coleoptera species of different families in each site of the Serra da Paranapiacaba.
Results and Discussion

Taxonomic survey.

Thirty one species of luminescent beetles were cataloged in the Serra da Paranapiacaba: 20 Lampyridae, 7 Elateridae, 4 Phengodidae and 1 Staphylinidae (Table 1). The richness of each family of luminous beetles in each conservation unit is summarized in Figure 2.

Lampyridae (Fig. 3). The number of observed lampyrid species was 10 in Carlos Botelho and 14 in the Intervales. In Tapiraí only five species were found (see Table 1). The smaller number found in Tapiraí could be due to the lower frequency and smaller scanned area of collecting made in this site. The following species were unique to Carlos Botelho: Aspisoma lineatum, Photinus sp1, Ethra aff. malledicta or axilaris, Lucidotini incertae sedis, Cladodes flabellicornis, Pyrogaster lunifer, Pyrogaster sp5 and Pyrogaster sp6. Seven species were found at Intervales but were not been found in Carlos Botelho and Tapiraí: Aspisoma physonotum, Aspisoma fenestrata, Amydetes lucernuta, Bicellonychia ornaticollis, Pyrogaster moestus, Photuris sp1 and Photuris sp7.

| Taxon | Tapiraí | PECB | PE Intervales | Reference collection |
|-------|---------|------|---------------|----------------------|
| **Lampyridae** | | | | |
| Cratomorphini | | | | |
| Aspisoma lineatum Gyllenhal | | | ok (4) | Col. MZUSP |
| Aspisoma physisomum Gorham, 1884 | | | ok (2,3) | Col. MZUSP |
| Aspisoma sp2 | | ok (1,2) | ok (1,2) | Col. V. Viviani |
| Cratomorphus besckei Olivier 1895 | | ok (2) | ok (2) | Col. MZUSP |
| Cratomorphus giganteus Druty, 1782 | | ok (1) | ok (1) | Col. MZUSP |
| **Photinini** | | | | |
| Photinoides jenai McDormott, 1963 | | ok* (1,2,3,4) | ok (1,2,3,4) | Col. MZUSP |
| Photinus sp1 | | ok (1) | ok (1) | Col. V. Viviani |
| Photinus sp6 | | ok (2) | | |
| **Lucidotini** | | | | |
| Ethra aff. malledicta or axilaris | | ok (1) | | * |
| Ethra aff. adicta | | ok (1) | | * |
| **Lamprocerini** | | | | |
| Cladodes demoulini | | ok (1) | | Col. MZUSP |
| Cladodes flabellicornis | | ok (1) | | Col. V. Viviani |
| **Amydetinae** | | | | |
| Amydetes lucernuta | | ok (4) | | |
| **Photurinae** | | | | |
| Bicellonycha sp. | | ok (3,4) | | |
| Bicellonycha sp8 | | ok* (3,4) | ok (3,4) | Col. V. Viviani |
| Pyrogaster lunifer Eschscholtz, 1822 | | ok (1) | | Col. V. Viviani |
| Pyrogaster moestus German 1824 | | ok (1,2) | ok (1,2) | Col. V. Viviani |
| Pyrogaster sp3 | | ok (1) | | PORTO (2011) |
| Photuris lugubris Gorham 1881 | | ok (1,2) | ok (1,2) | Col. V. Viviani |
| Photuris sp1 | | ok (1) | | Col. V. Viviani |
| **Phengodidae** | | | | |
| Mastinocerini | | | | |
| Stenophrixotrix sp1 | | ok (1) | ok (1) | ok (1) | Col. V. Viviani |
| Brasilocerus sp1 | | ok (1,2) | | |
| Phrixotrix hirtus Olivier, 1909 | | ok* (2) | | |
| **Phengodini** | | | | |
| Pseudophengodes sp1 | | ok (1,2) | | |
| **Elateridae** | | | | |
| Agrypininae/Pyrophorini | | | | |
| Hapsodrilus pyrotis German, 1841 | | ok (1) | ok (1) | ok (1) | Col. MZUSP |
| Pyroptesis cincticollis German 1841 | | ok (1,3) | ok (1,3) | Col. MZUSP |
| Petesinosia luculenta German, 1841 | | ok (1,2) | ok (1,2) | Col. MZUSP |
| Pyrearinus brevicollis Eschscholtz 1829 | | ok (1) | | |
| Pyrearinus candelarius German 1841 | | ok (1) | | |
| Pyrearinus micatus Costa 1978 | | ok (1,2) | ok (1,2) | Col. V. Viviani |
| Pyrophorus divergens Eschscholtz 1829 | | ok (1) | ok (1) | Col. V. Viviani |

Legenda: ok = ocorrência; ok* = ocorrência mas sem material fixado; (1) = floresta Montana; (2) = floresta úmida; (3) = áreas brejosas; (4) = áreas abertas. ** identificação pela chave.

Legend: ok = collected; ok* = occurrence recorded but no fixed material; (1) = montane forest; (2) = umid forest; (3) = marshy areas; (4) = open field. ** identification by key.

Results and Discussion

Taxonomic survey. Thirty one species of luminescent beetles were cataloged in the Serra da Paranapiacaba: 20 Lampyridae, 7 Elateridae, 4 Phengodidae and 1 Staphylinidae (Table 1). The richness of each family of luminous beetles in each conservation unit is summarized in Figure 2.

Table 1. Species of bioluminescent beetles collected in the three different sites of Serra de Paranapiacaba.

Tabela 1. Espécies de besouros bioluminescentes coletados nas três localidades de estudo na Serra de Paranapiacaba.
There is a unique species which was collected only in Tapirai – *Photinus sp9* – which displays a different bioluminescent signal from other *Photinus* species collected in Brazil, being characterized by a bimodal flash with bioluminescence spectrum peaking at 561 nm which is slightly blue-shifted in relation to other species of the genus found in the region (Viviani et al. 2010). Phengodidae. Only four species of phengodids were found in Paranapiacaba. In Carlos Botelho only the arboreal *Stenophrixotrix* sp1 larvae were
found. In Tapiraı´ Brasilocerus sp2 and Phrixotrix hirtus were found and in Intervales Pseudophengodes sp1. The arboreal Stenophrixotrix sp1 was common to all three areas. When compared with Boraceia, the number of species and abundance of phengodids was lower. The following species were found in both places: Brasilocerus sp2, Phrixotrix hirtus and Stenophrixotrix.

**Elateridae (Fig. 4).** The studied area was especially rich in luminescent click-beetles, with eight species: Hapsodrilus pyrotis Germar 1841, Hypsiophtalmus sp1, Ptesimopsia luculenta, Pyrearinus brevicollis, Pyrearinus candelarius, Pyrearinus micatus, Pyrearinus sp., Pyrophorus divergens. All these species were found at Intervales.

In Tapiraı´, four species of bioluminescent click-beetles were found: Pyrophorus divergens, Hypsiophtalmus sp1, Pyrearinus micatus and Pyrearinus candelarius. The species Hapsodrylus pyrotis, Ptesimopsia luculenta and Pyrearinus candelarius were not observed in Tapiraı´ and Carlos Botelho. Comparatively, Boraceia Biological Station showed only three species (Pyrophorus divergens, Pyrearinus micatus and Hapsodrilus pyrotis) and the municipalities of Campinas and Sorocaba four species (Hapsodrilus ignifer, Pyrearinus candelarius, Pyrearinus micatus and Pyrophorus divergens).

Considering that the surveys were conducted in the same morphoclimatic domain and continuous geographic Mountain Tropical Rain Forest, it was surprising that several of these species were not found more widely distributed among these areas. This could be due to two reasons: (1) there is more heterogeneity in the habitats than assumed, and the same kind of specific habitats were not sampled in the three localities, or (2) because the survey was not conducted simultaneously in the three areas. In this case, the seasonality of adults of a given species may vary between areas.

**Comparison with other sites of Atlantic forest.** When comparing this survey to Biol. St. of Boraceı´a, which is the second largest remnant of Atlantic Rainforest in São Paulo State, Paranapiacaba remnant showed a slightly smaller biodiversity. The following species were found in common in these two sites: Aspisoma physonotum Gorham 1884, Cratomorphus besceki Olivier 1895, Cratomorphus distinctus Olivier 1895, Photinus penai Germar 1824, Cladodes flabellicornis Motsch 1853, Pyrogaster moestus Germar 1824, Pyrogaster sp2, Photuris lugubris Gorham 1881, Photuris sp, Hapsodrilus pyrotis Germar 1841, Pyrophorus divergens Eschholtz 1829 and Pyrearinus micatus Costa 1978. Paranapiacaba forests were especially rich in...
elaterids, whereas Boracéia was richer in fireflies. When compared with the fragmented remnants of the semi-seasonal forests and secondary growths of urbanized areas of Campinas, Sorocaba and Rio Claro municipalities, only the following species were found in common: Aspisoma lineatum, Aspisoma phyllosomatum Gorham 1884, Cratomyopus distinctus Olivier 1895, Photinus sp., Photinus spz, Amydodes lucernata, Bicellonycha ornaticollis Blanch., Pyrogaster moestus Germar 1824, Photuris spz, Pyrearinus micatus Costa 1978 and Pyrophorus diversgens Eschholtz 1829. Thus, the species: Aspisoma fenestrata, Ethra aff maledicta or axillaris sp1, Photinus Gorham 1884, species were found in common: Sorocaba and Rio Claro municipalities, only the following families in places where they are visibly more abundant is shown on Fig. 5. There is an apparent trend for greater richness for all families in Mountain Forest. More refined analysis with quantification of abundance is required, to confirm whether the diversity of habitats is left, and how is the remaining forest distributed? Implications for ecological aspects of Brazilian railroadworms (Coleoptera: Phengodidae). 

Conclusions

The Serra de Paranapiacaba displays the second largest diversity of luminescent beetles in the Atlantic rain forest morphoclimatic domain of São Paulo state, with 34 species. Some species are common to sampled areas of semi-seasonal forest close to urbanized areas of inner São Paulo state and to the second largest and most preserved area of Biological Station of Boracéia. This area is especially rich in elaterid luminescent beetles, but displays poorer diversity of Phengodidae.

Acknowledgements

We are grateful to Dra. Simone Polieca Rosa (MZUSP) for the identification of the specimens to Edipo F. v. da Silva and Pedro R. Busana (UFSCar) for assistance in the field activities and to Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) and Biota Project - FAPESP (Proc. 2011/19427-9) for financial support.

References

COSTA, C. 1971. Gênero Pyrophorus. 4. Redescrição e revalidação de Pyrophorus diversgens Eschholtz (Coleoptera, Elateridae). Pápeis Avulsos Zool., 2(4):65-72.
COSTA, C. 1971. Gênero Pyrophorus. 5. Redescrição de Pyrophorus ignitus (Fabricius) (Col., Elateridae). Pápeis Avulsos Zool., 2(4):113-116.
COSTA, C. 1971. Gênero Pyrophorus. 6. Redescrição de P. tuberculifer Eschholtz, P. phosphorecent Castelnau e descrição de quatorze espécies novas (Col. Elateridae). Pápeis Avulsos Zool., 2(5):19-227.
COSTA, C. 1975. Systematics and evolution of the tribes Pyrophorini and Heligmini with description of Campyloxyeninae, a new subfamily. Arquivos Zoológicos, 2, pp. 49-190, http://dx.doi.org/10.11606/issn.2176-7793.s262p49-190.
COSTA, C. 2000. Estado de Conhecimento de os Coleoptera Neotropicales. PRIBES, Zaragoza, Spain. (F. Martín-Pérez, J.J. Morone, & A. Melic, Eds.) Zaragoza, Spain: PRIBES.
COSTA, C., VANIN, S.A. & CASARI-CHEN, S. 1988. Larvas de Coleoptera do Brasil. São Paulo: Museu de Zoologia (Universidade de São Paulo), http://dx.doi.org/10.5962/bhl.title.100233.
COSTA, C., VANIN, S.A. & VIVIANI, V.R. 1999. Larvas of Neotropical Coleoptera. XXVII. Phrixotrixis hirtus Olivier, 1909, Descriptions of Immatures neotenic female, adult male and bionomic data (Phengodinae, Phengodidae, Coleoptera). Ilheringia, 3a. Ser. Zool. (86):9-28.
COSTA, C., VANIN, S. & COLEOPICOLO NETO, P. 1986. Larvas de Neotropical Coleoptera XIV: First record of bioluminescence in the family Staphylinidae (Xantholini). Revista Brasileira de Entomologia, (30):101-104.
DA SILVEIRA, L.F. & MERMUDES, J.R.M. 2014. Systematic review of the firefly genus Amydodes Illiger, 1807 (Coleoptera: Lampyridae), with 13 description of new species. Zootaxa, 3765(3):201-248, http://dx.doi.org/10.11606/zootaxa.3765.3.1.
GALLETI JR, P.M., RODRIGUES, F.P., SOLECAVA, A.M., MIYAKI, C.Y., CARVALHO, D., EIZIRIK, E. et al. 2008. Geneética e conservação de quatorze species novas (Col. Elateridae), Pápeis Avulsos Zool., V.24(4):65-72.
HAGEN O, SANTOS, R.M., SCHLINDWEIN, M.N., VIVIANI, V.R. 2014. Artificial Night Lighting Reduces Firefly (Coleoptera: Lampyridae) Occurrence in Sorocaba, Brazil. Adv. in Entomol, 3:24-32. 2015, http://dx.doi.org/10.4236/ae.2015.31004.
LLOYD, J.E. 2006. Stray Light, fireflies and fireflyers. In: C. Rich, & T. Longcore, Ecological Consequences of Artificial Night Lighting (pp. 345-364), Washington DC.: Island Press.
RIBEIRO, M.C., METZGER, J.P., MARTENSEN, A.C., PONZONI, F.J., HIROTA, M.M. 2009. The Brazilian Atlantic Forest: How much is left, and how is the remaining forest distributed? Implications for conservation. Biological Conservation, 142(6):1141-1153, http://dx.doi.org/10.1016/j.biocon.2009.02.021.
ROSA, S.P. 2007. Description of Photiturus fulvipes Blanchard immatures (Coleoptera: Lampyridae; Photorubinae) and bionomic aspects under laboratory conditions. Revista Brasileira de Entomologia, 2(51):125-130, http://dx.doi.org/10.1590/S0085-56262007000200001.
VIVIANI, V.R. 1989. Descrição dos estágios imaturos e dados biológicos de Aspisoma sp. (Coleoptera: Lampyridae). Revista Brasileira de Entomologia, 2(33):359-366.
VIVIANI, V.R. 1999. Fireflies (Coleoptera: Lampyridae) from South-eastern Brazil:Habitats, Life History, and Bioluminescence. Ann. Entomol. Soc. Am., 1(94):129-145, http://dx.doi.org/10.1603/0013-8746(2001)094[0129:FLFSB2.0.CO;2.
VIVIANI, V.R. 2007. Luciferases de vagalumes. Biотecnologia e Desenvolvimento, 37(8)-19.
VIVIANI, V.R. & BECHARA, E.J. 1997. Bioluminescence and biological aspects of Brazilian railroadworms (Coleoptera: Phengodidae).
