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Front cover | Capa: Plain tiger *Danaus chrysippus* (Linnaeus, 1758), Santo Antão, Cape Verde Islands, 22 November 2011 (Yann Coatanéa).

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Surgical repair of a large shell injury in a loggerhead sea turtle *Caretta caretta* and the need for a wildlife recovery centre in the Cape Verde Islands

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Keywords: fracture, shell, field surgery, sea turtle, *Caretta caretta*, *in situ* conservation, rehabilitation

ABSTRACT

On 12 July 2013, an adult female loggerhead sea turtle *Caretta caretta* with an almost complete longitudinal carapace fracture was observed nesting and returning to sea at João Barrosa beach, Boa Vista, Cape Verde Islands. Due to the evident fracture instability and the likelihood of subsequent system infection development, an intervention was planned to prevent further health decline and eventual death. Beach surveillance was increased to raise recapture possibilities, based on the most likely nesting days for this individual. After 53 days, the animal hauled out again and was allowed to lay eggs before taken away for wound cleaning, stabilization, medication administration and surgery. An orthopaedic surgical intervention for shell repair was performed under field injectable general anaesthesia. The fracture was stabilised in six places by means of four marine resistant stainless steel plates and two orthopaedic wires screwed to the carapace. Finally, all implanted material was covered and protected with epoxy resin to maintain a smooth carapace surface and prevent potential entanglement.

RESUMO

Em 12 de Julho de 2013, uma tartaruga comum *Caretta caretta* fêmea foi observada nidificando e regressando ao mar, com uma enorme fratura longitudinal na carapaça. A observação foi feita na praia de João Barrosa, ilha da Boa Vista, ilhas de Cabo Verde. Dada a instabilidade da fratura e a probabilidade de desenvolvimento de infeção sistémica, foi planeada uma intervenção para evitar a degradação da ferida e eventual morte do indivíduo. A vigilância da praia foi reforçada para aumentar a possibilidade da recaptura da fêmea, com base nos dias mais prováveis de nidificação. Após 53 dias, o indivíduo emergiu de novo para nidificar. Após a desova, foi transportado para um local onde foi feita a limpeza e estabilização da ferida, bem como a administração de fármacos. Foi depois realizada uma intervenção cirúrgica sob anestesia geral para reparação da carapaça. A fratura foi fixada em seis pontos diferentes por meio de quatro placas e dois arames de aço inoxidável presos à carapaça. Finalmente, todo o material implantado foi coberto e protegido com resina epóxi para manter a superfície da carapaça lisa e evitar potencial emaranhamento.

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INTRODUCTION

The International Union for the Conservation of Nature (IUCN) classifies the loggerhead sea turtle *Caretta caretta* as endangered (Marine Turtle Specialist Group 1996). The Cape Verde Islands have the third largest nesting population of this species in the world (Marco *et al*. 2010, 2012). The increasing pressure on this region due to the explosive growth of mass-tourism can have a large impact on the conservation status of the species. Indeed, the Cape Verde population represents one of the world's eleven most endangered populations considered as regional management units (Wallace *et al.* 2011).

Human activities (anthropogenic factors) are considered one of the major worldwide threats to sea turtle conservation (Mader 2005, Norton 2005). Human usage of the sea encompasses direct interaction with sea turtles (e.g. fisheries bycath, poaching, nest destruction, boat strikes, etc), but also activities that indirectly lead to detrimental effects on sea turtle populations (e.g. environmental degradation, pollution, global warming) (Lutz & Musick 1997, Marco *et al*. 2010, 2011). For example, ship strikes present a life-threatening danger to sea turtles, especially when hit by keel or boat propellers, potentially causing multiple kinds of injuries (Orós *et al*. 2005, Work *et al*. 2010). Natural factors can also contribute to adult female mortality. Several dozens of females are rescued every nesting season in Boa Vista as some animals become desorientated in wetlands adjacent to nesting beaches or have difficulty in passing small cliffs that they encounter on their way from the beach back to the sea. Turtles can also bump against rocks and suffer severe fractures of the carapace or can get stuck between rocks.

The loss of adult females can have a great impact on the future of sea turtle populations (Wyneken *et al.* 2008). On the one hand, the energy expense of reaching sexual maturity is considerable. On the other hand, the reproductive potential of one female sea turtle is exponential. For these reasons, a high pressure on adult females can be directly responsible for population decline and eventual extinction.

In this paper, the case of an adult female loggerhead sea turtle treated in order to repair a large carapace fracture is presented. The importance of this kind of rescue actions is evaluated, taking into account their contribution to the conservation of sea turtles by considering biological and educational aspects.

CASE REPORT

On 12 July 2013, an adult female loggerhead turtle with an almost complete longitudinal parasagittal shell fracture was found at João Barrosa beach, Boa Vista Island (Fig. 1). Previously, the animal had been PIT-tagged by NGO Cabo Verde Natura 2000 with code 116524270A at Ervatão beach on 11 July 2003, ca. 5 km from the site where it was found in 2013.

The injury comprised the cranial aspect of the carapace, through the lateral right side of the spine, until three-quarters of the total curved carapace length (from the nuchal scute through all five right costal scutes). Additonally, a triangular piece of shell was loose, only attached by soft tissue, in the central area of the fracture. Fracture edges looked active and displaced significantly during normal animal movement. The female successfully dug a nest chamber, deposited 86 eggs and covered and camouflaged the nest. Because of the unusual finding and lack of material for treating the animal on location at the time, the turtle was allowed to return to the sea in the hope of finding it again during the next beaching episode, with everything prepared on site to attempt surgical carapace cleaning and stabilization.

Fig. 1. The injured turtle during the first encounter on 12 July 2013 (Adolfo Marco).

Logistics put in place included a facility area to keep the animal calm, clean and safe until surgical intervention was possible. Additionally, veterinary advice was required to design an operation plan suitable to field work conditions and material availability. It was decided to perform a field orthopaedic surgery, aiming at a detailed examination of the fracture's extension and a permanent surgical solution to prevent further deteriorating and fracture progression and to allow proper wound healing.

Beach surveillance was increased during the most likely nesting days to maximize the possibility of detecting the female. Loggerheads of the Boa Vista population usually nest 4-6 times every 14-18 days. Eventually, the animal was found back on the same beach on 3 September 2013, 53 days after the first encounter (Fig. 2).

Fig. 2. The injured turtle immediately before surgery (Vanesa Martínez).

After nesting and laying 83 eggs, the turtle was placed in a large plastic container in a wet, calm and clean environment. Following veterinary advice, wound cleaning and medication administration was performed on a daily basis during 12 days. Physical examination of the sea turtle suggested that it was strong enough to overcome anaesthesia and sufficiently fit for surgical intervention. The procedure was carried out at NGO BIOS.CV's field camp at João Barrosa on 16 September 2013. To ensure the best medical assessment and dosage administration, the animal was weighted using a large field scale. The turtle's body weight was 67 kg and the straight carapace length was 88 cm.

General anaesthesia was achieved by intravenous injection of propofol (7 mg/kg; Propofol-Lipuro® 10 mg/kg, B. Braun Vet-Care SA, Barcelona, Spain). Meloxicam (0.2 mg/kg; Metacam® 5 mg/ml, Boehringer Ingelheim Vetmedica GmbH, Ingelheim am Rhein, Germany) was used for pain relief and anti-inflammatory effect. Antibiotic coverage was achieved with intramuscular enrofloxacin (5 mg/kg; Baytril® 5%, Bayer Hispania SL Barcelona, Spain) prior to surgery and subcutaneous long acting ceftiofur (15mg/kg; Naxcel® 100 mg/ml, Pfizer Limited Puurs, Brussels, Belgium) postsurgery. During surgery, muscular tone and reflexes and cardiovascular performance monitoring by Doppler flow unit (Minidop ES-100VX, Hadeco, Japan) were used for anaesthesia plane follow up (McArthur *et al.* 2004) (Fig. 3). An intravenous catheter (Venofix® A, 21 G, Braun, Melsungen, Germany) was placed into the cervical dorsal sinus to allow adequate fluid therapy administration (1000ml saline FisioVet®, Braun

Fig. 3. Monitoring the turtle's vital functions (Vanesa Martínez).

VetCare SA, Barcelona, Spain) to improve anaesthesia recovery and acupuncture point GV26 was used to decrease recovery time (Canion & Rogers 2006).

Deep debridement of the wound and tissue and bone necrotic removal (Fig. 4) was performed before complete fracture reduction. For fracture reduction and stabilization, marine stainless steel plates with 5 mm screws were chosen to ensure permanent shell stability (Piermattei *et al*. 2006). To complete fracture repair, cerclage orthopaedic wire was used to fix the detached central shell piece (Fig. 5). In order to prevent entanglement with marine debris and to minimize epibiont adhesion to or around implanted material, bone plates, wire and bone screws were covered with an epoxy layer (Fig. 6). Once the turtle was fully recovered from two hours anaesthesia, it was released on the beach (Fig. 7). The animal responded quickly by approaching the water and entered the sea as normally observed in females after egg laying.

Fig. 4. Fracture cleaning and debridement. Fig. 5. Orthopedical fixation of the carapace fracture (Rosa García Cerdá).

Fig. 6. Protective epoxy application to the fixed carapace. Fig. 7. The sea turtle named Laura, painted for easier resighting, is released on the beach (Rosa García Cerdá).

DISCUSSION

Several conclusions can be drawn from this case. First of all, the singular biological value of a breeding female sea turtle of an endangered population (Wallace *et al*. 2011) justified the performance of this exercise. In Cape Verde, many sea turtles are severely injured every year by both anthropogenic and natural causes. Up to 20% of nesting females are found to have injures on their bodies and other injured turtles are found death on the beaches and at sea. The present study case is a good example of the utility and efficacy that a well-organized programme of rescue and rehabilitation of sea turtles could have in Cape Verde. In this particular case, a rehabilitation facility would have helped in conducting an adequate health assessment of the animal prior to surgery. Moreover, the procedure would have been executed in a well-equipped surgery room and follow up controls could have been made after the surgery to ensure correct recovery of the wound. In addition, a rescue center could serve as a supporting unit for conservation management and scientific research. It can also be used to bring local people, especially the youth, into contact with sea turtles through educational activities.

Another important point to consider is the social upshot of this kind of actions involving charismatic animals such as sea turtles and the possibility to increase (or create) public awareness or even fundraising for conservation. The use of current means of communication, such as social networks, to spread the word about actions and international interest will ensure better local and international reach and, at the same time, are effective tools for getting feedback. In the example described here, the amazing response received from social networks and the follow-up and interest shown by the general public (e.g. http://youtu.be/-rBpKIKfiV0, http://tinyurl.com/q7cnxwo), reflect the potential of this kind of events for raising interest in wildlife conservation. National media also gave attention to this case and the news was released on national television and radio and in newspapers, even arguing for local political involvement in sea turtle conservation.

Apart from these public awareness aspects, valuable clinical information was obtained from surgery and anaesthesia, to the benefit of future field technical work. Finally, but not less important, taking the opportunity for experience exchange with technical personnel, perform practical *in situ* work and share experiences and materials, significantly promoted knowledge diffusion and improved surgical skills and interest among local staff.

Fig. 8. Part of the staff involved in the turtle's rehabilitation at the João Barroso field camp (Pedro López).

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The haematophagous arthropods (Animalia: Arthropoda) of the Cape Verde Islands: a review

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Keywords: Arthropods, arthropod-borne diseases, bloodsucking, hematophagy, Cape Verde Islands

ABSTRACT

Arthropoda is the most diverse phylum of the animal kingdom. The majority of bloodsucking arthropods of public health concern are found in two classes, Arachnida and Insecta. Mosquitoes, ticks, cattle flies, horseflies and biting midges are the main hematophagous groups occurring in the Cape Verde Islands and whose role in infectious disease transmission has been established. In this literature review, the main morphological and biological characters and their role in the cycle of disease transmission are summarized.

RESUMO

Os artrópodes constituem o mais diverso entre todos os filos do reino animal. É na classe Arachnida e na classe Insecta que encontramos a maioria dos artrópodes com importância na saúde pública. Os mosquitos, os carrapatos, as moscas do gado, os tabanídeos e os mosquitos pólvora são os principais grupos hematófagos que ocorrem em Cabo Verde e possuem clara associação com a transmissão de agentes infecciosos. Nesta revisão da literatura apresentamos os principais caracteres morfológicos e biologicos e o seu papel no ciclo de transmissão de doenças.

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INTRODUCTION

With over a million described species, Arthropoda is the most diverse and species rich clade of the animal kingdom. Five main taxonomic groups are usually recognized: the extinct Trilobitomorpha and the extant Chelicerata, Miriapoda, Hexapoda and Crustacea (Ruppert & Barnes 1994). Because they represent an important source of food, transmit numerous infectious agents and include an array of agricultural pest species, arthropods are widely studied (Chown & Nicolson 2004). Haematophagous arthropods occur in two major groups, i.e. Arachnida (Chelicerata) and Insecta (Hexapoda) (Fig. 1), and are vectors of pathogens worldwide. So far, more than 16,000 haematophagous species have been identified, of which *ca*. 500 are strongly associated with the transmission of infectious agents (Grimaldi & Engel 2005, Lehane 2005). It has been estimated that of infectious diseases worldwide, about 17% are vector-borne. Unfortunately, vaccines for most of these diseases are not available. Therefore, increased emphasis on vector control strategies is required, based upon the selection of proven intervention methods tailored to biological characters and ecological circumstances of local vectors (WHO 2004).

The terrestrial arthropod fauna of the Cape Verde Islands was reviewed by van Harten (1993), while a summary update was recently provided by Arechavaleta *et al*. (2005). In Cape Verde, several vector-borne diseases occur.

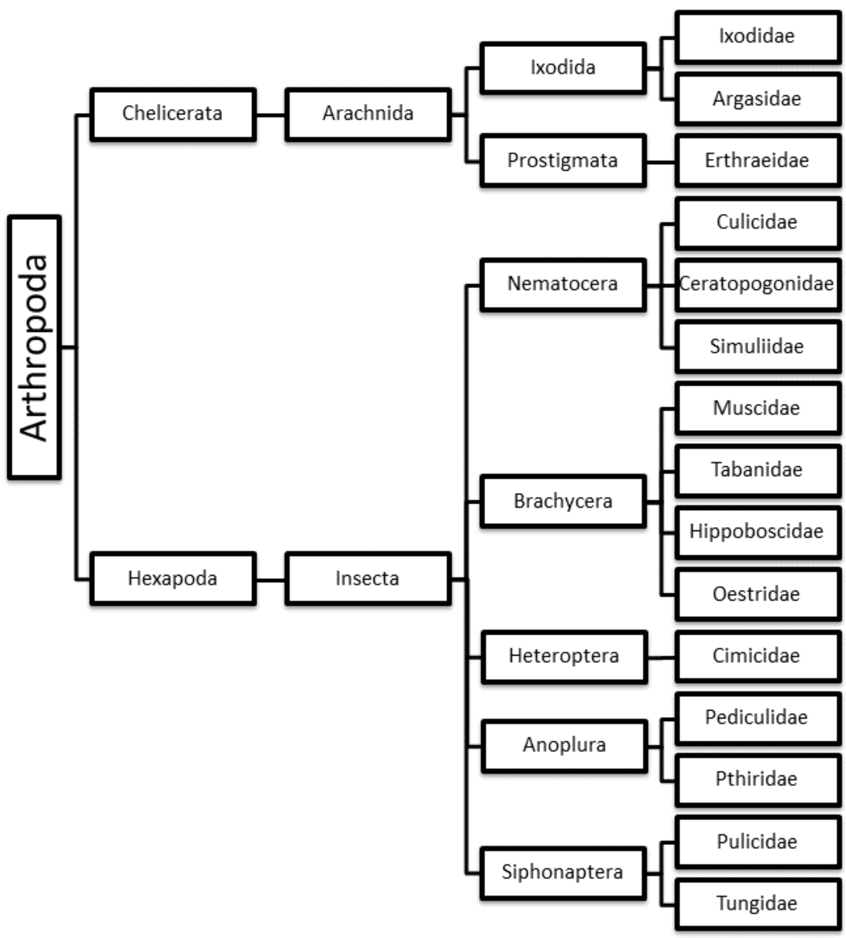

Fig. 1. Main groups of haematophagous arthropods occurring in the Cape Verde Islands. Modified after Lehane (2005) and Estrada-Peña *et al.* (2010).

Many of these are emerging and/or re-emerging as a result of ecological and environmental changes that favour increased vector densities (Gratz 1999). In order to reduce the chance of (re)emergence of arthropod-transmitted diseases, knowledge of local vector populations is crucial in tracking any changes in their biology. This review was conducted in order to draw attention to the importance of bloodsucking arthropods in the Cape Verde archipelago and to better understand their role in the most common infectious agent transmissions. The result will hopefully be useful in making policy decisions and in formulating new strategies in the fight against vector-borne diseases in the Cape Verde Islands.

METHODS

The literature was scanned using the PubMed, Google Scholar and SCIELO databases from January 2013 to December 2013. Combinations of the following key words were used: arthropods, arthropod-borne disease, blood-sucking, haematophagy and Cape Verde Islands. Three different languages (English, French, Portuguese) were used to obtain results. Unpublished reports in national institutions (e.g. Ministry of Health, Ministry of Rural Development, National Library, National Historical Archive) were also scrutinized. Relevant references were organized in a spreadsheet, but only those references actually mentioning bloodsucking arthropods were maintained. Using the same databases, the medical and/or veterinary importance of the references was assessed. Medical and/or veterinary importance was allotted when at least one infectious agent was isolated in the wild or when experimental infection was successfully realized in the laboratory.

RESULTS

The database search resulted in 22 publications (articles, books, reports) mentioning the presence of haematophagous arthropods in the Cape Verde Islands. Of extant bloodsucking arthropods, only Lepidoptera (represented by a single haematophagous species in Southeast Asia) do not occur in the archipelago. Only one study (on mosquitoes) was conducted exclusively by national researchers (Duarte *et al.* 2012). Also focusing on mosquitoes, six publications were published by a combined team of national and foreign workers (Appendix 1). The remaining studies were conducted solely by foreign workers and dealt with ticks, cattle flies, horseflies, biting midges, blackflies, mites, fleas and lice. Publications appeared in 19 journals and other sources (Appendix 1). Up until now, a role in the disease transmission cycle has been confirmed for three taxonomic groups in the Cape Verde archipelago (see group descriptions below).

TICKS (ARACHNIDA: ACARI: IXODIDA)

Ticks are mandatory ectoparasites that parasitize a variety of vertebrates and cause direct and indirect financial loss (Parola & Raoult 2001, Estrada-Peña *et al*. 2010). This large group is subdivided into three families: i) Ixodidae (hard ticks), with over 700 species, including the most important vectors; ii) Argasidae (soft ticks), comprising *ca*. 200 species; iii) Nuttalliellidae, with a single species (*Nuttalliella namaqua*), exclusively found in southern Africa (Parola & Raoult 2001, Basu *et al*. 2012).

Being arachnids, ticks can be easily distinguished from insects by having three pairs of appendices during the immature stage and four pairs as adults, by having the mouthpart transformed into chelicerae and by the absence of wings (Randolph 1998). Only few studies on ticks have been conducted in the Cape Verde Islands (Tendeiro 1954, Meira *et al*. 1957, Kirchner *et al*. 2008, Götsch *et al*. 2009, Gómez-Díaz *et al*. 2012). All except the study by Gómez-Díaz *et al*. (2012) were conducted fully or partially in Santiago Island. Recent studies showed domestic animals to be highly parasitized and it was recommended to prevent transportation of animals (especially dogs) from Cape Verde to Europe (Kirchner *et al*. 2008, Götsch *et al*. 2009). *Ripicephalus sanguineus* was the only species found in recent studies, although other species such as *Amblyomma variegatum*, *Margaropus decoloratus* and *Hyalomma* sp. had previously been reported (Tendeiro 1954, Meira *et al*. 1957), all of them

Ixodidae. The most recent study of ticks conducted in the archipelago (Gómez-Díaz *et al*. 2012) dealt with diversity and genetic structure of *Ornithodoros capensis*, a parasite of seabirds.

LIFE CYCLE

Ticks have a complex life cycle, which – depending on family, species and environmental parameters – may take 2-3 years (Parola & Raoult 2001). Their feeding behaviour is also complex. Hard ticks need a long time to feed (2-15 days) and feeding only takes place once during each stage (larva, nymph and adult). Soft ticks consume several meals per stage but, unlike hard ticks, these may take from a few minutes to a few hours (Vial 2009). Approximately 75% of a hard tick's life cycle is spent while being attached to an animal (Parola & Raoult 2001), whereas soft ticks only attach to animals to feed (Vial 2009).

MEDICAL AND VETERINARY IMPORTANCE

African swine fever (ASF) is a highly contagious and extremely deadly disease in domestic pigs (FAO 2000) and is one of the most important tick-borne ailments in Cape Verde. Ticks of the genus *Ornithodoros* play an important role as vector of the disease (Basto *et al*. 2006). Although there is no consensual view on their precise role in ASF transmission, the persistence of the disease after several veterinary interventions and absence of transmission during various months (Penrith 1998) suggests that vectors or pigs (or both) act as reservoirs.

No human diseases transmitted by ticks are known to occur in the archipelago. Lyme disease is an illness caused by the spirochete *Borrelia burgdorferi s.l.* and is transmitted by hard ticks of the genus *Ixodes* (Karami 2012), but has not been found in Cape Verde so far. Beyond their implication in disease transmission, ticks themselves pose problems to both man and animals because they cause various harmful side-effects to the host, ranging from anaemia caused by massive infestation to allergy due to the inoculation of saliva during blood meals (Lehane 2005).

MOSQUITOES (INSECTA: NEMATOCERA: CULICIDAE)

Mosquitoes are dipteran insects belonging to the family Culicidae, in which three subfamilies are recognized: Anophelinae, Culicinae and Toxirhichitinae (Consoli & Lourenço de Oliveira 1994). Diptera have only one pair of wings, the forewings, while the hindwings are reduced to dumbbell-shaped knobs called halteres. They have long legs and antennae, chipper-shaped mouthparts adapted to suction and generally show marked sexual dimorphism (Consoli & Lourenço de Oliveira 1994, Harbach 2007). In the Cape Verde archipelago, 11 species of mosquitoes occur, representing two subfamilies, i.e. Anophelinae (two species in one genus) and Culicinae (nine species in three genera) (Ribeiro *et al.* 1980, Alves *et al.* 2010, in press). Of these, about half is involved in the transmission of infectious agents, particularly *Anopheles arabiensis*, *Aedes aegypti* and two members of the *Culex pipiens* complex (*C. p. pipiens* and *C. p. quinquefasciatus*) (Alves *et al*. 2010).

LIFE CYCLE

During their life cycle, mosquitoes pass through four stages: eggs, larvae, pupae and adults, of which the first three are aquatic (Consoli & Lourenço de Oliveira 1994, Lehane 2005). The larvae feed mostly on organic particles in water, while pupae only use the energy stored during the larval stage. Adult mosquitoes are terrestrial, this being the stage of reproduction and dispersion. Males feed exclusively on plant fluids, while females need animal (including human) blood for the maturation of their eggs (Consoli & Lourenço de Oliveira 1994).

MEDICAL AND VETERINARY IMPORTANCE

In Cape Verde, mosquitoes have been identified as vector of several infectious agents that cause malaria, yellow fever, lymphatic filariasis and, more recently, dengue (Franco & Menezes 1955, Ribeiro *et al*. 1980; Alves 2004, WHO 2009).

A. arabiensis is the only member of the *A. gambiae* complex occurring in Cape Verde (Cambournac *et al*. 1982, Diallo 2003, Alves *et al*. 2010, Dia *et al*. 2011). In addition to being the only vector of malaria, it was also the vector of *Wulchereria brancrofti*, the infectious agent causing lymphatic filariasis (Franco & Menezes 1955). Since the 1950s, no new cases of lymphatic filariasis have become known in Cape Verde and the decease has seemingly been eradicated in the islands. In a recent study conducted in all inhabited islands, no cases were diagnosed (Benzerroug 2005). Before the 1950s, the annual incidence of malaria was more than 100 cases/1000 inhabitants (Rodriguez *et al*. 2012), but currently only limited and localized transmission occurs in two (Santiago and Boa Vista) of the 10 islands (WHO 2012).

Epidemic dengue fever occurred in Cape Verde in 2009 when *ca*. 21,000 cases were reported (WHO 2009, Monteiro 2010), mainly in Santiago and Fogo Islands. *A. aegypti*, the only vector of dengue described in the archipelago (Alves *et al*. 2010), was also the only vector of yellow fever, being resistant to DDT 4% and also suspected to be resistant to propoxur (Dia *et al*. 2012). During the dry season, it takes advantage of household water containers for its reproduction, thus maintaining high densities over the reproductive period (Duarte *et al*. 2012, 2013). Using experimental infection techniques, it has been shown that *A. aegypti* (ssp. *formosus*) from Santiago Island has a moderate ability to transmit dengue virus serotype 3, but a high susceptibility of becoming infected with and to transmit chikungynya (CHIKV) and yellow fever virus (Vazeille *et al*. 2013).

Despite their role in the transmission of several infectious agents in other countries, the two members of the *C. pipiens* complex that occur in Cape Verde have as yet not been associated with infectious agent transmission. Elsewhere, these taxa are instrumental in the transmission of West Nile virus, *Wulchereria brancrofti*, Rift Valley fever viruses, encephalitis viruses and others (Turell 2012). In Cape Verde, *C. p. quinquefasciatus* was first documented in 1950 (although the presence of *C. pipiens s.l.* had already been reported in 1947), while the occurrence of *C. p. pipiens* was established in 1977 (Ribeiro *et al*. 1980). Based on morphological studies of the male genitals, Ribeiro *et al*. (1980) identified hybrids *C. p. pipiens* x *C. p. quinquefasciatus*. This was subsequently confirmed by molecular analysis (Alves *et al*. 2010, Gomes *et al*. 2012). These hybirds have been shown to have the ability to enhance arbovirus transmission in areas where they occur (Gomes *et al*. 2012).

CATTLE FLIES (INSECTA: BRACHYCERA: MUSCIDAE)

Cattle flies are bloodsucking ectoparasites of mammals (especially cattle) in the genus *Stomoxys*. They are similar to houseflies *Musca domestica*, but the distinguishing character is the cattle flies' mouthparts, which are adapted to bloodsucking (Zumpt 1973). Both males and females feed on blood. Three species occur in Cape Verde, i.e. *Stomoxys calcitrans*, *S. niger* and *S. sitiens* (Arechavaleta *et al*. 2005), of which only *S. calcitrans* has anthropophagic preferences.

LIFE CYCLE

During their life cycle, cattle flies go through four stages: egg, larvae, pupae and adult (Lehane 2005). The eggs are laid in groups of 40 to 80. Hatching occurs approximately 24 hours after laying, while larval development time depends on temperature and other environmental conditions. After the last instar, larvae move to dry areas for pupation. Adults live for about 30 days, with males on average living slightly longer than females (Zumpt 1973, Lehane 2005).

MEDICAL AND VETERINARY IMPORTANCE

Cattle flies are characterized by having interrupted blood meals and they can bite several hosts during the course of the same feeding round. This has important epidemiological consequences (Zumpt 1973). Therefore, their economic damage is categorized as either direct or indirect. Direct damage is inflicted by blood spoliation, decrease in immune defense (inducing latent diseases), production loss, diminished weight, etc. Indirect damage is caused by the transmission of viruses, bacteria and other infectious agents (Zumpt 1973, Lehane 2005).

S. calcitrans is a pest species with a worldwide distribution, known for disturbing cattle and causing considerable losses (Lehane 2005). The species can also transmit trypanosomes, mainly *Trypanosoma equinum* in Neotropical countries and *T. evansi* (which causes severe disease in horses and dogs and less severe illness in cattle) and it has a secondary role in the transmission of the infectious agent causing African trypanosomiasis or sleeping sickness (Lehane 2005). The only reported link between *S. calcitrans* and disease in Cape Verde occurred in the past, when its larvae caused myiasis among humans (Azevedo & Moreira 1946).

HORSEFLIES (INSECTA: BRACHYCERA: TABANIDAE)

Horseflies are robust insects (adults: 5-25 mm) with a cosmopolitan distribution. The males feed on plants, while the hematophagous females also feed on nectar (Middlekauff & Lane 1980, Lehane 2005). Their head is larger than the thorax, the mouthparts are of the chipper/sucking type and they have long antennae. The Tabanidae comprise more than 4,300 described species in more than 130 genera and three subfamilies (Tabaninae, Chrysopsinae, Pangoninae) of which the first two are the epidemiologically more important (Lehane 2005). *Atylotus agrestis* is probably the only species that occurs in the Cape Verde Islands (Arechavaleta *et al*. 2005).

LIFE CYCLE

The life cycle of horseflies includes eggs, larvae (with 6-13 stages), pupae and adults. Egg laying occurs in aquatic environments and eggs hatch 2-3 days after laying. Larvae also need humid environments to survive; they are carnivorous and feed on small invertebrates. Horseflies can remain at the larval stage for up to two years before transforming into pupae. After 1-3 weeks, adults emerge and live for about two months. Mating occurs soon after emergence and females lay their eggs only after having consumed blood meals (Middlekauff & Lane 1980, Lehane 2005).

MEDICAL AND VETERINARY IMPORTANCE

Horseflies possess some characteristics that favour the transmission of infectious agents: only few species are autogenous (most require a blood meal for egg maturation), they are telmophagous (skin deceleration during blood meal), they require a fair amount of blood (and thus have a long engorgement time) and they interrupt their meal due to being chased off because of their painful bite, thus seeking another host (Middlekauff & Lane 1980, Lehane 2005). They may transmit a large variety of infectious agents, including bacteria, viruses, protozoa, filariae and others. Anthrax, anaplasmoses, Q fever, trypanosomiasis, filariasis, encephalitis and African swine fever are some of the diseases transmitted (Lehane 2005). Because some of these diseases occur in Cape Verde and due to the fact that *Atylotus agrestis* is associated with the transmission of some infectious agents (Desquesnes & Dia 2003a, 2003b), further studies are needed to clarify the role of this species as a vector in the archipelago.

BITING MIDGES (INSECTA: NEMATOCERA: CERATOPOGONIDAE)

Biting midges are small (1-4 mm) flies of the family Ceratopogonidae, having composed eyes, chipper-shaped mouthparts, short legs and the abdomen divided into 10 segments (Mellor *et al.* 2000). With the exception of New Zealand, Patagonia, the Hawaiian Islands and the polar regions, they have a worldwide distribution. The genus *Culicoides* includes *ca*. 1,400 species of which 96% engage in bloodsucking (females only). They parasitize mammals (including humans) and birds (Mellor *et al.* 2000, Zimmer *et al*. 2008). *C. imicola* – the main vector of African horse sickness virus (AHSV) and Bluetongue virus (BTV) in Africa – *C. schultzei* and *C. nivosus* occur in the Cape Verde archipelago (Boorman & van Harten 1992).

LIFE CYCLE

The *Culicoides* life cycle includes eggs, four larval stages, pupae and adults. The immature stages require humid places to survive (Kettle 1977, Mellor *et al.* 2000). Breeding sites are similar to those of mosquitoes. Eggs are laid at the substrate surface and, depending on species and environmental conditions, hatching occurs 2-7 days after laying (Mellor *et al.* 2000). Larvae feed on vegetal debris, but some species are predators. Pupae can be found moving free in the water or fixed on the substrate. Depending on the species, adults are active during daylight or twilight, possess only limited capacity for flight and dispersal and are generally passive (Kettle 1962, 1977, Mellor *et al.* 2000).

MEDICAL AND VETERINARY IMPORTANCE

Worldwide, more than 50 arboviruses have been isolated from *Culicoides*, sometimes playing a secondary role in the transmission cycle (Mellor *et al.* 2000). Many species transmit infectious agents causing diseases in animals, but only few of them in humans. Among infectious agents transmitted, Rift Valley fever (RVF) virus, African horse sickness (AHS) virus, bluetongue virus (BTV), equine encephalitis viruses and epizootic hemorrhagic disease (EHD) virus are some examples (Mellor *et al.* 2000, MacLachlan & Guthrie 2010). Two of these agents, AHSV and BTV (Orvivirus, Reoviridae), cause diseases of significant international impact and have been reported in the Cape Verde Islands (Sellers *et al*. 1977, Boorman & van Harten 1992). AHSV is a non-contagious disease that causes 90% mortality in infected horses and has been introduced in Cape Verde from Senegal (Sellers *et al*. 1977, MacLachlan & Guthrie 2010). Nine serotypes of AHSV that occur in Africa are transmitted by *C. imicola* and *C. bolitinos* (MacLachlan & Guthrie 2010).

OTHER TAXA

A single species of black fly (Nematocera: Simuliidae), *Simulium ruficorne*, occurs in the Cape Verde archipelago (Arechavaleta *et al*. 2005). Worldwide, there are about 1,800 species of black flies in 25 genera, of which four are of public health concern: *Austrosimulium*, *Cnephia*, *Prosimulium* and *Simulium* (Lehane 2005).

These black flies transmit *Onchocerca volvulus*, which causes onchocerciasis in Africa, but in Cape Verde *S. ruficorne* has as yet not been shown to be a vector of infectious agents.

Not surprisingly, *Cimex hemipterus* (Heteroptera: Cimicidae), the common bedbug, also occurs in Cape Verde (van Harten 1993, Arechavaleta *et al*. 2005). Both sexes are hematophagous and preferably bite at night (Lehane 2005). Although they are suspected of transmitting infectious agents, the role of bedbugs in spreading them is not clear and there is no clear evidence for their involvement in the transmission of disease agents (Delaunay *et al*. 2011).

Both Hippoboscidae (louse flies) and Oestridae (botflies) occur in the Cape Verde archipelago (van Harten 1993, Arechavaleta *et al*. 2005). Van Harten (1993) cited three species for the archipelago: *Hippobosca rufipes, H. equine* and *Olfersia aenescens*. Worldwide, more than 200 species have been described and several of them have been implied in the transmission of infectious agents (e.g. Rahola *et al.* 2011). *Oestrus ovis* is the only species of botfly occurring in Cape Verde and it has been implicated in causing myiasis in several species elsewhere in the world (Denion *et al.* 2004).

Although many species of mites (Siphonaptera) have been confirmed to occur in the Cape Verde Islands (Mahunka 1991, Arechavaleta *et al*. 2005, Haitlinger 2009), only Eryrthraeidae (*Leptus salicus*, *L. korneli*, *Erythraeus capeverdensis*) may have some degree of hematophagous habits. Although few data are available for these species, it has been shown elsewhere that *Balaustium* mites (Eryrthraeidae) have very generalized feeding habits, including references to attacks on humans causing dermatitis (Newell 1963, Ido *et al*. 2003).

It appears that all taxa of lice (Anoplura) that affect humans occur in the Cape Verde archipelago, i.e. *Pediculus humanus* (Pediculidae) and *Pthirus pubis* (Pthiridae) (van Harten 1993, Arechavaleta *et al*. 2005). Louse-borne diseases affect all levels of society, but they are most common under poor hygienic circumstances and extreme poverty. Of the two, only *P. pubis* is associated with sexual activity (Brouqui 2011).

Among the 2,000 species of fleas (Siphonaptera) that have been described (Krasnov 2008), at least four occur in the Cape Verde archipelago, i.e. *Ctenocephalides felis*, *Pulex irritans* and *Echidnophaga gallinacea* (Pulicidae) and *Tunga penetrans* (Tungidae) (Gomes 1969, Arechavaleta *et al*. 2005). *P. irritans* and *T. penetrans* have a preference for human blood (Lehane 2005, Krasnov 2008). They are potential vectors of numerous infectious agents, among them viruses and bacteria, and especially *Yersinia pestis*, the causal agent of Black Death (Lehane 2005, Krasnov 2008).

CONCLUSIONS

Although many bloodsucking arthropods, including known vectors, occur in the Cape Verde Islands, only few studies have been carried out on their biology and role in disease transmission in the archipelago. Most studies have largely or exclusively been carried out by foreign researchers, illustrating the need to encourage local research teams to study the biology of these species, which include several taxa imposing serious threats to public health, and obtain a better understanding of their environmental requirements in Cape Verde.

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APPENDIX 1. Haematophagous arthropods of the Cape Verde Islands and sources used in this review.

Taxonomic group	**Authors**	**Source**	**Taxa**	**Researchers (Cape Verde and/or Foreign)**
Mosquitoes (Insecta: Nematocera: Culicidae)	Ribeiro *et al*. (1979)	Journal	*Anopheles gambiae s.l.*	Foreign
	Ribeiro *et al*. (1980)	Book	*Aedes aegypti*, *Ae. caspius meirais*, *Anopheles gambiae s.l.*, *An. pretoriensis*, *Culex bitaeniorynchus* (Syn. *Cx. ethiopicus*), *Cx. p. pipiens*, *Cx. p. quinquefasciatus*, *Culiseta longiareolata*	Foreign
	Cambournac *et al*. (1982)	Journal	*Anopheles arabiensis*	Foreign
	Cambournac *et al*. (1984)	Journal	*Culex tigripes*	Foreign/CV
	Diallo (2003)	Report	*Anopheles arabiensis*, *An. pretoriensis*, *Aedes aegypti*, *Culex pipiens s.l.*	Foreign
	Alves *et al*. (2010)	Journal	*Aedes aegypti*, *Ae. caspius*, *Anopheles arabiensis*, *An. pretoriensis*, *Culex bitaeniorynchus* (Syn. *Cx. ethiopicus*), *Cx. perexiguus*, *Cx. p. pipiens*, *Cx. p. quinquefasciatus*, *Cx. pipiens s.l.* hybrids, *Cx. tigripes*, *Culiseta longiareolata*	CV/Foreign
	Dia *et al*. (2011)	Report	*Anopheles arabiensis*, *An. pretoriensis*, *Aedes aegypti*, *Ae. caspius*, *Culex bitaeniorynchus* (Syn. *Cx. ethiopicus*), *Cx. pipiens s.l.*, *Culex sp.*	Foreign/CV
	Dia *et al*. (2012)	Journal	*Aedes aegypti*	Foreign
	Duarte *et al*. (2012)	Journal	*Aedes aegypti*, *Anopheles gambiae s.l.*, *Culex* sp.	CV
	Vazeille *et al*. (2012)	Journal	*Aedes aegypti* ssp. *formosus*	Foreign/CV
	Duarte *et al*. (2013)	Journal	*Aedes aegypti*	CV/Foreign
	Alves *et al*. in press	Journal	*Culex tritaeniorhynchus*	CV/Foreign

APPENDIX 1 continued.

Ticks (Arachnida: Ixodida)	Tendeiro *et al*. (1954)	Journal	*Amblyomma variegatum*	Foreign
	Meira *et al*. (1957)	Journal	*Amblyomma variegatum, Hylomma sp., Margaropus decoloratus, Rhipicephalus sanguineos*	Foreign
	Kirchner *et al*. (2008)	Journal	*Rhipicephalus sanguineos*	Foreign
	Götsch *et al*. (2009)	Journal	*Rhipicephalus sanguineos*	Foreign
	Gómez-Díaz *et al*. (2012)	Journal	*Ornthodoros capensis*	Foreign
Cattle flies (Insecta: Brachycera: Muscidae)	Arechavaleta *et al*. (2005)*	Book	*Stomoxys calcitrans, S. sitiens, S. niger*	Foreign
Horse flies (Insecta: Brachycera: Tabanidae)	Arechavaleta *et al*. (2005)	Book	*Atylotus agrestis*	Foreign
Biting midges (Insecta: Nematocera: Ceratopogonida)	Boorman & van Harten (1992)	Journal	*Culicoides imicola, C. schultzei, C. nivosus*	Foreign
Other taxa	van Harten (1993)	Journal	*Simulium rificorne, Ctenocephalides felis, Echidnophaga galinácea, Pulex irritans, Tunga penetrans, Pediculus humanus, Pthirus pubis, Cimex hemipterus, Hippobosca rufipes, H. equina, Olfersia aenescens, Oestrus ovis*	Foreign
	Haitlinger (2009)	Journal	*Leptus salicus, L. korneli, Erythraeus capeverdensis*	Foreign

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Dragonflies and damselflies (Insecta: Odonata) collected during the Lindberg expedition to the Cape Verde Islands, 1953-54

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Keywords: Odonata, dragonflies, damselflies, Cape Verde Islands, Håkan Lindberg, museum collection

ABSTRACT

In this paper, 47 specimens of dragonflies and damselflies collected by H. Lindberg and his assistant S. Panelius in the Cape Verde Islands in 1953-1954 and identified by K.J. Valle and K.F. Buchholz, are presented. The damselfly *Agriocnemis exilis* Selys, 1872, collected in Boa Vista Island in February 1954, is added to the list of Odonata known from the archipelago. The collection also includes specimens from another damselfly, *Ischnura senegalensis* (Rambur, 1842), which was previously recorded in Cape Verde on only two occasions, in 1898 and 2000.

RESUMO

Apresentam-se, neste texto, 47 exemplares de libélulas e libelinhas das ilhas de Cabo Verde. Os exemplares foram recolhidos em 1953-54 por H. Lindberg e pelo seu assistente S. Panelius e foram identificados por K.J. Valle e K.F. Buchholz. A libelinha *Agriocnemis exilis* Selys, 1872, capturada na ilha da Boa Vista em Fevereiro de 1954, constitui um novo taxon na lista de espécies de Odonata do arquipélago. A colecção também inclui exemplares de uma outra libelinha, *Ischnura senegalensis* (Rambur, 1842), que até então apenas tinha sido observada em Cabo Verde em duas ocasiões, em 1898 e 2000.

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INTRODUCTION

The Cape Verde Islands have a small but peculiar fauna of Odonata, with the number of resident species being equal to that of accidental species. The geographical position of the archipelago in the eastern Atlantic Ocean, between latitudes 15-17ºN, 500-700 km off continental West Africa, the scarcity of surface freshwater bodies, accentuated by prolonged periods of drought, and winds that almost invariably blow both during the nine months dry season and the three months wet season, are limiting factors that apparently prevent the establishment of a more diverse odonate assemblage.

Compiling a complete list of resident species does not require much effort and this task has essentially been achieved during the last decade (e.g. Aistleitner *et al.* 2008, Martens *et al.* 2013). Although some questions remain unanswered, no big surprises are to be expected. As for accidental species, however, the number of questions remaining unanswered is considerable - the checklist is not yet a done deal and the number of records, both of species and individuals, is small. This is partly a consequence of the scant survey effort and the inaccessibility of some of the terrain, while the environmental conditions that propitiate the arrival of migrants and vagrants remain largely unknown.

With field survey effort falling short, museum collections become a valuable resource for obtaining faunistic data, in particular on accidental species. A recent paper on two historical collections (Martens *et al*. 2013) brought to light two new taxa for the archipelago, i.e. *Anax rutherfordi* McLachlan, 1883 and *Anax tristis* Hagen, 1867. The current paper presents data on yet another historical collection of odonates from Cape Verde, brought together by the Finnish naturalist Håkan Lindberg (1898-1966) and his assistant Samuel Panelius (1934-) between November 1953 and March 1954. In doing so, a new taxon is added to the list of odonate species known from the Cape Verde archipelago.

Lindberg conducted a four-months zoological expedition to the Cape Verde Islands with the aim of increasing knowledge of the invertebrate terrestrial fauna of the archipelago (Lindberg 1958). Lindberg and Panelius visited the islands of São Vicente, Santa Luzia, São Nicolau, Santo Antão, Sal, Boa Vista, Maio, Santiago, Fogo, Brava and three of the Rombos islets, and collected specimens of different animal groups, as well as vascular plants. Special attention was given to insects, but other arthropods, molluscs and lizards were also collected.

MATERIAL AND METHODS

Odonate specimens were collected by Håkan Lindberg and Samuel Panelius and are kept at the Zoologisches Forschungsmuseum Alexander Koenig (ZFMK), Bonn, Germany. The collection includes 38 larvae preserved in ethanol and nine adults stored dry in envelopes. Almost all of the specimens have metadata labels on which the collector gave locality and date of capture. Names of those who identified specimens are also given. Adult specimens – but not the larvae – have museum catalogue numbers. Although most of the collection has never been published, the specimens were studied and identified by Kaarlo Johannes Valle (1887-1956), a Finnish odonatologist, and by Karl Friedrich Buchholz (1911-1967), Curator of Herpetology at ZFMK. Valle published several papers on odonates from Madeira, Azores and Canary Islands (Weihrauch 2011), based on Lindberg's collections from these islands. I examined all Cape Verde specimens and did not find any problematical identifications. Special attention was given to the new taxon for the Cape Verde archipelago reported herein, using Pinhey's (1974) key. Whenever a specimen's condition allowed, larvae were measured using a digital calliper. Geographical coordinates given in the list of collecting localities were assigned by the author, based on the 1:25,000 topographical maps published during the 1960s by the Serviço Cartográfico do Exército, Portugal, and on Google Earth imagery, using the list of collecting localities given in Lindberg (1958). However, coordinates must be viewed with caution, since data on the specimen labels are limited. Brief descriptions of habitats in the following are derived from Lindberg (1958).

COLLECTING LOCALITIES

SANTO ANTÃO
(1) Ribeira do Brás (rendered 'Rb. Braz' on label), Sinagoga; brook with halophyte vegetation: 17º10'30"N, 25º01'50"W, 28-xii-1953.
(2) Tarrafal de Monte Trigo (rendered 'Tarrafal' on label); sparse vegetation along brook (supposedly 'Ribeira do Tarrafal'): 16º57'30"N, 25º18'30"W, 12-iii-1954.

SÃO NICOLAU
(3) Ribeira Brava; brook with orchards along banks, abundant vegetation in valley and sparse vegetation on slopes and hill sides: 16º37'30"N, 24º17'45"W, 6-8 and 19-xii-1953.

BOA VISTA
(4) Sal-Rei; dunes, sandy fields and salt-pans, *Phoenix atlantica* orchards: 16º10'55"N, 22º54'55"W, (a) 29-i-1954, (b) 1-ii-1954.
(5) Rabil; riparian vegetation along almost desiccated 'Ribeira do Rabil': 16º07'50"N, 22º52'45"W, 31-i-1954.

SPECIMENS COLLECTED

Agriocnemis exilis Selys, 1872
BOA VISTA: (4b) 1 adult male [ZFMK cat. no. ODO 2008/5], H. Lindberg coll., K.F. Buchholz det. First record for the Cape Verde archipelago (Fig. 1-3).

Fig. 1. *Agriocnemis exilis*, head, thorax and legs (partim) of ZFMK ODO 2008/5. Photograph by the author.

Fig. 2. *Agriocnemis exilis*, wings of specimen ZFMK ODO 2008/5. Photograph by the author.

Fig. 3. *Agriocnemis exilis*, abdomen (partim) of specimen ZFMK ODO 2008/5. Photograph by the author.

Ischnura senegalensis (Rambur, 1842)
BOA VISTA: (5) 1 adult, sex indeterminable as abdomen is fragmented and incomplete [ZFMK cat. no. ODO 2009/741-1], H. Lindberg coll., K.F. Buchholz det.; (5) 1 adult female [ZFMK cat. no. ODO 2009/741-2], H. Lindberg coll., K.F. Buchholz and K.J. Valle det.

Anax imperator Leach, 1815
SANTO ANTÃO: (1) 1 larva, H. Lindberg coll., K.J. Valle det., total length 19 mm.
SÃO NICOLAU: (3) 23 larvae, S. Panelius coll., K.J. Valle det., total length ranging from 10 to 38 mm. First records for the island.
BOA VISTA: (4a) 1 adult male [ZFMK cat. no. ODO 2010/1477], S. Panelius coll., K.J. Valle det.

Crocothemis erythraea (Brullé, 1832)
SÃO NICOLAU: (3) 1 adult female [ZFMK cat. no. ODO 2010/2397], H. Lindberg coll., K.J. Valle det.; (3) 1 larva, S. Panelius coll., K.J. Valle det.
LOCALITY UNKNOWN: 1 adult male [ZFMK cat. no. ODO 2010/2398], collector and date not

given, K.J. Valle det.; 1 adult female [ZFMK cat. no. ODO 2010/2399], collector and date not given, K.J. Valle det.

Orthetrum trinacria (Selys, 1841)
SÃO NICOLAU: (3) 1 larva, S. Panelius coll., K.J. Valle det.

Pantala flavescens (Fabricius, 1798)
SÃO NICOLAU: (3) 9 larvae, S. Panelius coll., K.J. Valle det. First record for the island.
Trithemis annulata (Palisot de Beauvois, 1807)
SANTO ANTÃO: (2) 1 adult male [ZFMK cat. no. ODO 2011/521], H. Lindberg coll., K.F. Buchholz and K.J. Valle det.
SÃO NICOLAU: (3) 3 larvae, S. Panelius coll., K.J. Valle det.

Zygonyx torridus (Kirby, 1889)
SÃO NICOLAU: (3) 1 adult male [ZFMK cat. no. ODO 2011/644], H. Lindberg coll., K.F. Buchholz and K.J. Valle det. This is the only specimen from the Lindberg Cape Verde odonate collection that has previously been published (cf. Aistleitner *et al*. 2008).

DISCUSSION

The Lindberg collection from Cape Verde contributes one new taxon to the archipelago's list of Odonata, i.e. *Agriocnemis exilis*, collected at Sal-Rei, Boa Vista, 1 February 1954. The two records of *Ischnura senegalensis*, collected at Rabil, Boa Vista, are also noteworthy because of the rarity of zygopterans in Cape Verde. The specimens of larvae include two new taxa - *Anax imperator* and *Pantala flavescens* - for São Nicolau. Adding the new data to the checklist recently published by Martens *et al.* (2013), the number of odonate species known from Cape Verde increases to 17, being four zygopterans and 13 anisopterans. While seven of the anisopterans are residents (Loureiro *et al.* 2013, Martens *et al.* 2013), all zygopterans appear to be accidental visitors.

A. exilis, the newly recorded taxon, is a small odonate, widespread throughout sub-Saharan Africa except in rainforest regions. In West Africa, it is known from Senegal to Nigeria and Chad. It is a sedentary species occurring in swamps, swampy pools and rivers (Clausnitzer *et al.* 2010). Despite its minute size, *A. exilis* managed to reach the Cape Verde Islands, probably aided by favorable winds, and the possibility that the species occasionally reproduces in the archipelago cannot be excluded. The wide distribution of the species in Africa, possibly due to prevailing air currents, was remarked upon by Pinhey (1984). The presence of another zygopteran specimens - *I. senegalensis* - in the Lindberg collection, taken on the same island and one day before the other, is interesting and contributes to the hypothesis that there exists a genuine connection between favorable winds and the occasional occurrence of accidental dragonflies and damselflies in the Cape Verde archipelago, particularly in the easternmost island of Boa Vista.

Movements of the desert locust *Schistocerca gregaria* (Forskål, 1775), which occasionally plagues Cape Verde, are monitored by the Food and Agriculture Organization of the United Nations (cf. FAO 2014). Locust movements from continental West Africa (Mauritania, Western Sahara, Senegal) to the Cape Verde Islands, as well as between islands within the archipelago, are facilitated by favorable winds that could also carry accidental odonate visitors. Possibly, the movements of *S. gregaria* can be used to better understand the origin and pathway of odonates that have only occasionally been reported from Cape Verde.

Fig. 4. *Agriocnemis exilis*, female, collected aboard ship, *ca.* 100 nm off West Africa in November 1893. © Zoologisches Museum Hamburg.

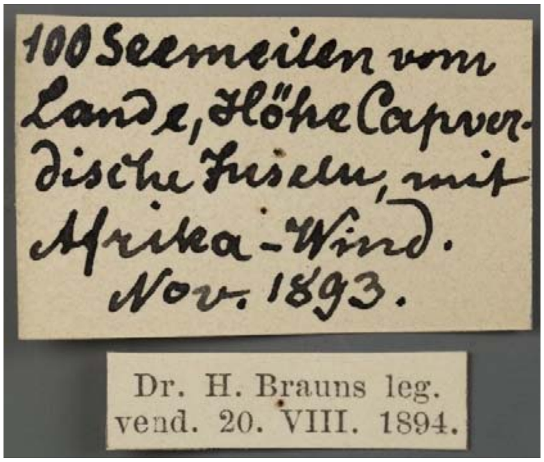

Fig. 5. Labels of *Agriocnemis exilis* collected aboard ship, *ca.* 100 nm off West Africa in November 1893. © Zoologisches Museum Hamburg.

Saraiva (1962) mentioned two severe invasions of *S. gregaria*, the first one in 1893 and the second in 1949. Fea (1898) also reported that a large locust invasion had occurred in Boa Vista during the 1890s. The first record of *I. senegalensis* in Cape Verde is of a specimen collected in Boa Vista in 1898 (Aistleitner *et al.* 2008). The second record of *I. senegalensis* and the first of *A. exilis* are both from 1954 (this paper). Interestingly, a female *A. exilis* (without number) in the collections of the Zoologisches Museum Hamburg, Germany, was collected aboard ship *ca.* 100 nm off the West African coast, at the latitude of the Cape Verde Islands, in November 1893 (Fig. 4, 5). It may not be by chance only that locust invasions more or less coincide with the occurrence of damselflies in the Cape Verde Islands.

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Short note | Nota breve

First confirmed occurrence of Gervais' beaked whale *Mesoplodon europaeus* (Gervais, 1855) in the Cape Verde Islands

Franziska Koenen, Edita Magileviciute, João Rodrigues & Cornelis J. Hazevoet

Keywords: Cetacea, *Mesoplodon*, Gervais' beaked whale, Cape Verde Islands, Maio Island, stranding

On 15 May 2013, on the beach near Calheta de Baixo, Maio Island, Cape Verde Islands (15º13′20″N, 23º13′12″W), the remains of a stranded cetacean were found. The animal had been butchered by local inhabitants and most of the flesh and blubber, as well as the intestines, had been removed, while the tail fluke had been chopped off (Fig. 1). However, with the skull still present, it was immediately clear that it concerned a beaked whale *Mesoplodon* sp. The single pair of teeth (one of which was broken) placed back from the apex in the lower jaw (Fig. 2) allowed the animal to be identified as a male Gervais' beaked whale *M. europaeus* (Gervais, 1855). The intact tooth was removed from the left side of the jaw (Fig. 3) and preserved in 70% ethanol. Tooth height from tip to end of root was 7.1 cm. The following body measurements were taken – length of rostrum from tip to external nares: 53 cm; length of mandible from tip to root: 60.5 cm; width of skull at widest point: 38 cm. Total length (from tip of beak to last vertebra) was 3.80 m, which – compensating for the chopped off fluke – is within the normal range of male Gervais' beaked whale (cf. MacLeod 2006). A skin sample was taken and preserved in 96% ethanol. In addition, the stomach was recovered, which – except for two unidentified fragments of squid beaks – proved to be empty. Skull and skeleton were buried and will remain so for at least 12 months to clear the bones from the remaining tissue. All samples and skeletal parts are (or will be, in the case of those parts still buried at present) curated at the premises of the Fundação Maio Biodiversidade (Porto Inglês, Maio) and will be available for future study.

Fig. 1-2. Gervais' beaked whale *Mesoplodon europaeus*, Calheta de Baixo, Maio, Cape Verde Islands, 15 May 2013. © Fundação Maio Biodiversidade.

Fig. 3. Tooth of Gervais' beaked whale *Mesoplodon europaeus*, Calheta de Baixo, Maio, Cape Verde Islands, 15 May 2013. © Fundação Maio Biodiversidade.

Local inhabitants at the stranding site were asked whether the animal, when first encountered, was still alive, but answers were ambiguous and it was not possible to get an unequivocal opinion. However, the very fact that it was butchered suggests that the whale must have been very fresh, if not indeed alive. Due to the mutilated state of the carcass, it was not possible to assess the possible cause of the stranding through post-mortem dissection.

This is the first confirmed record of Gervais' beaked whale for the Cape Verde Islands, as well as the first registered stranding of a beaked whale in the archipelago. Four beaked whales observed and photographed off the island of Sal in February 2010 were only tentatively identified as *Mesoplodon* cf. *europaeus,* because none of the pictures clearly showed the diagnostic beak (Hazevoet *et al.* 2010).

As is the case with beaked whales in general, little is known about the life history of Gervais' beaked whale and almost all data on its biology and distribution come from stranded animals. *M. europaeus* is catagorized as 'data deficient' in the IUCN Red List of Threatened Species (Taylor *et al.* 2008).

Mesopelagic cephalopods appear to be the primary food of *M. europaeus* and indeed of all beaked whales (Mead 1989, Norman & Mead 2001), which agrees with the fragments of squid beaks found in the Maio specimen's stomach. The species appears to be largely restricted to deep waters of the warm-temporate and tropical Atlantic, with the large majority of records coming from the western North Atlantic (Mead 1989, Norman & Mead 2001, MacLeod *et al.* 2006). In the western Atlantic, the northernmost record is from Massachusetts, USA (Moore *et al.* 2004) and the southernmost from São Paulo State, Brazil (Santos *et al.* 2003). Most records in the western Atlantic are from the southeastern USA and the Caribbean region (e.g. Mead 1989, Debrot 1998, Debrot *et al.* 1998, Rosario-Delestre *et al.* 1999, Norman & Mead 2001, MacLeod *et al.* 2006). In the eastern Atlantic, the northenmost (presumably extralimital) records are from Ireland (Berrow & Rogan 1997), the English Channel (type locality, hence the specific epithet) (Gervais 1855, Deslongchamps 1866) and France (Van Canneyt *et al*. 1999). Further south, there are records from Portugal (Sequeira *et al.* 1992, 1996) and Spain (Valverde & Galán 1997) and there is a single record (most likely a vagrant) from the Mediterranean (Podestà *et al.* 2005). In Macaronesia, there are records of Gervais' beaked whale in the Canary Islands (Martin *et al.* 1990, 2004, Carillo *et al.* 2010), Madeira (Freitas *et al.* 2012) and the Azores (Reiner *et al.* 1993). In West Africa, there is a stranding record from Mauritania (Robineau & Vely 1993), while Reiner (1980) reported a skull found at an unspecified location in Guinea-Bissau. In the eastern Atlantic, the southernmost records are from Ascension Island (Mead 1989) and northern Namibia (Wojtek & Norman 2014). There are as yet no records from West African waters from the Gulf of Guinea to Angola (Weir 2010), which may be due to the lack of local stranding reporting schemes and trained cetologists rather than to the absence of beaked whales.

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