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Social and Health Impact of Flying Hymenoptera Stings: Experience in a Region of Central Hill Country of Sri Lanka

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Abstract

Objectives: Stinging by Asian giant honey bee and hornets is a common environmental hazard leading to many hospital admissions in Sri Lanka. This study aims to study the social and health impact of flying hymenoptera stings in a region of the central hill country of Sri Lanka. **Methodology:** The study was carried out at the two base Hospitals in Teldeniya and Rikillagaskada, Sri Lanka. All the patients presented to these hospitals following a wasp or big bee singing, during the period of 2011–2010 were included in the study. **Results:** There was a total of 80 patients in this study cohort, with 54 (32%) of them being victims of Horne stings and the rest being big bee stings (*n* = 26, 68%). The mean age of the total group was 45 years (SD = 16). Stings occurrence between 9.00 am and 3.00 pm was more frequent. The majority of the big bee stings (*n* = 26, 48%) had occurred while working in tea estates, whereas the hornet attacks were frequent around the dwellings (*n* = 12, 46%), head and neck (*n* = 72, 90%), upper limbs (*n* = 48, 60%), chest (*n* = 28, 35%), and back of the chest (*n* = 24, 30%) were the commonly involved body regions. **Conclusions:** Hymenoptera stings have a significant social and health impact in a region of the central hill country of Sri Lanka. Although pain and swelling were the most common adverse effect, life-threatening anaphylaxis was not reported in this study group. Even though electrocardiogram changes were more common among big bee groups, none of them were fatal.

Keywords: Big bee, Hornet, Hymenoptera, Sri Lanka, Stings

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Introduction

Sri Lanka, a tropical island in the Indian Ocean, is located to the South of the Indian subcontinent. It lies between 5° 55′ and 9° 55′ north of the equator and between the eastern longitudes 79° 42′ and 81° 52′. The total land area is 65,610 sq. km. and is astonishingly varied with a length of 445 km and a breadth of 225 km. The island consists of a mountainous mass somewhat south of the center, with a height exceeding 2500 m surrounded by broad plains.[1] Hymenopterans are insects broadly categorized into three families: Apidae (honeybees, bumblebees), (Vespidae hornets, wasps, and yellow jackets), and Formicidae (fire ants).[2] In Sri Lanka, there are three reported species of hornets belonging to the genus Vespa namely *Vespa affinis* (Linnaeus), *Vespa tropica* (Linnaeus), and *Vespa mandarinia* (Smith).[3] Old world paper wasp *Ropalidia marginata* is found in the Indian peninsula.[4] The domesticated Asian honeybee, *Apis cerana* ("Meemessa"), the feral giant honeybee, *Apis dorsata* ("Bambara"), the feral dwarf honeybee *Apis florae* ("Daduwal mee"), and the stingless bee, *Trigona iridipennis* ("Kaneyya messa") are common honey bees found in rural and urban areas in Sri Lanka.[5] This article presents the social and health impact attributable to the stings by two categories of commonly found hymenoptera species in Sri Lanka. One species belongs to the Apidae family, the Asian giant honey bee (*A. dorsata*), and the other belongs to the Vespidae family, the hornet (*V. affinis*). In local language Giant Asian honey bee is called *Bambara* and *Karunge kalavi* in Sinhala and Tamil languages, respectively. Moreover, the hornet is called *Debara* and *Onaan* in Sinhala and Tamil languages, respectively.

Asian giant honey bees feed on nectar. They are a social hymenoptera species and show an aggressive attacking behavior as a defensive measure. This species is quite widely distributed in tropical Southeast Asia, as well as parts of Nepal, India, Sri Lanka, and China[6-8] [Figure 1].

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This species is distinctly bigger than the common honeybee and longer in overall shape.[8] These bees make honey, which is highly prized, and equally difficult to obtain and do not nest in crevices as common honeybees. They make large, semicircular, or elongated combs which can even exceed a meter. These combs are exposed and hung on trees; there is no outer covering or envelope of any sort, but the combs are protected by layers of bees which almost completely cover them in an active nest. The nests are usually very high in trees, and rock faces away from human access. [Figure 2] According to some villagers, they are even more aggressive than the hornets and show much more persistence in pursuing intruders. Asian giant honey bees are vital honey producers and pollinators of cultivated crops and wild plants. Colonies in Sri Lanka travel for a month or so, up to 200 km in each direction, resting in trees along the way.[9]

Honey collectors in Sri Lanka, climb trees at night, and smoke or burn the hive to drive the bees away and then collect

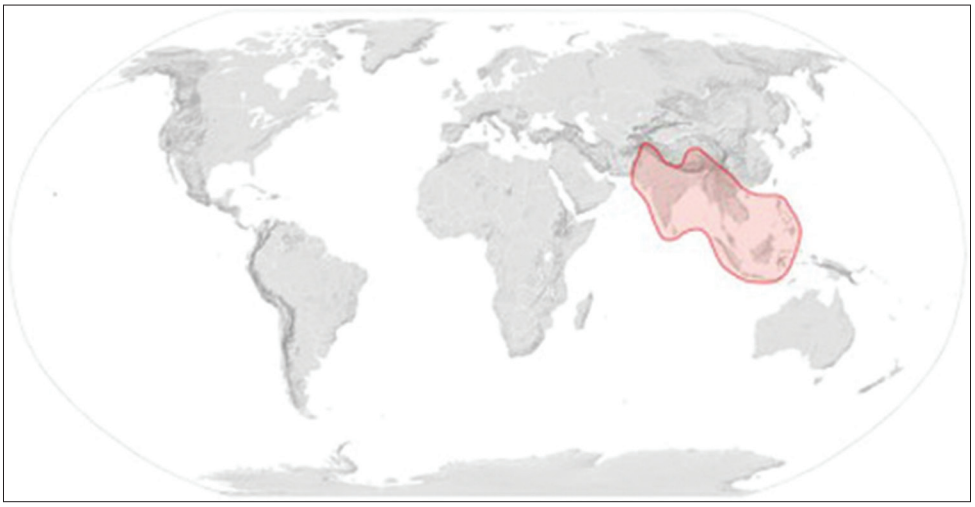

Figure 1: The distribution of *Apis dorsata*. Source: Sémhur Canuckguy, via Wikimedia Commons

Figure 2: Asian giant honey bees nests are usually very high in trees

the honey. Another method, described by an elderly man in Teldeniya, is to light a fire at the base of the tree at night, and then disturb the hive, on which the bees are driven away or burnt to death. The combs could then be removed. Indigenous people of Sri Lanka (Veddas) who dwell in large forests of the dry zone are specially skilled to harvest honey from these combs. The world-famous historical Sigiriya rock of Sri Lanka and Bambaragala is abundant of combs of Giant honey bees, and there are numerous incidents of attacking visitors on witnessed or none witnessed provocation. Very often, travelers, trackers, and pedestrians are the potential victims of the heavy attack. So far, attempts to domesticate these bees have failed. Although they show strong migratory behavior, according to an article, in Singapore, it can be found at almost every time of the year, and they are especially numerous in August and September.[8] Unlike the wasps and hornets, bees are completely herbivorous. A giant honeybee is approximately 17–20 mm long and has a stinger apparatus attached to its viscera ovipositor. It generally stings once only as it dies after an attack because the barbed stinger, as well as the venom sac, is usually detached from the body and left embedded in the victim's skin.[2,10] Clinically, this finding helps to differentiate giant honey bee stings from hornets stings as the hornets do not leave their stinger in the skin of the victim.[3] The stinger apparatus of the giant honeybee has its own musculature and ganglion, which keep on delivering venom even after detachment for few seconds. The honey Bee's venom, known as apitoxin, carries several active components, the most abundant of which is melittin, and the most destructive is phospholipase A2[1,4] [Figure 3].

The common and widely distributed hornet in Sri Lanka is *V. affinis* which belongs to the genus *Vespa*.[11] [Figure 4] Hornets construct their nests on tall structures, near or on buildings, under eaves of roofs, or in natural nesting sites such as trees, shrubs, and rock faces. These nests are composed of a paper substance derived from saliva and wood pulp. [Figure 5] Hornets feed on sugary liquids of plants as well as on other insects, which even could be other bees. Rather than consume their kills directly, the hornets chew them into a paste and feed them to their larvae (adult hornets being unable to digest solid protein). The hornet larvae, in return, produce a clear liquid, a powerful energy-boosting cocktail in their saliva, which the adults consume.[12] Unlike bees with barbed stingers, the Vespidae (wasps, hornets, and yellow jackets) species have no barbs and can sting repeatedly without damaging or losing the stinging apparatus.[13,14] The venom of a hornet contains eight different chemicals including a mixture of histamine-releasing factors, enzymes, hemolysis, neurotoxins, vasodilators, vasospastic amines, and phospholipase A.[11] The systemic and toxic effects of Vespid venom can include acute kidney injury, hemolysis, rhabdomyolysis, liver impairment, and coagulation abnormalities.[14] Despite the fact that the venom of the Asian Giant Hornet is incredibly potent, it is only in rare cases when the person is more vulnerable, that it is actually the poison that has caused them to die.

Victoria Randenigala and Rantambe Sanctuary are a forest reserve and are located in Central Sri Lanka. The estimate terrain elevation above sea level is 874 m. The latitude is 7°10'33.96" and the longitude is 80°55'44.05".[2] This sanctuary is composed of evergreen forests belong to both wet and dry zones, and it covers about 420 km^2 of the island.[15] The Victoria is the largest of the chain of reservoirs built along the river Mahaweli. Two banks are now abandoned with human habitats including villages, towns, farms, and estates which are in close contact with the forests. During years 2011–2012, authors had the opportunity to manage the victims of stung by Asian giant honey bee and

Figure 3: Giant honey bee or Big bee sting site. Source: https://www.google.lk/search?q=big+bee+stings&rlz=1C1CHBD_enL K710LK710 & source=lnms&tbm=is ch&sa=X&ved= 0ahUKEwjymYX16__ YAhVKL48KH cUcAKQQAU ICigB&biw= 1280&bih= 637#imgrc= JWc5rfAmNmXbiM

Figure 5: Hornet's nest. Source: https://www.google.lk/search?q=hornets+nest&rlz= 1C1CHBD_enLK710LK710&source=lnms&tbm=isch&sa=X&ved=0ahUKEwi7-LPO7 P_YAhXIPo 8KHfMsAHYQ_AUI CigB&biw=1280&bih=637#im grc=7Px1HR4l4XhnvM

Figure 4: *Vespa affinis*. Source: https://www.google.lk/search?q=Vespa+affinis&rlz =1C1CHBD_enLK710LK710&source =lnms &tbm=isch&sa=X&ved =0ahUKEwj155u_7f_YAhXBQY8KHT v-CBYQ_AU ICigB&biw=1280&bih=637#imgrc=8KDubpbAVqDfrM

hornets admitting to District Base Hospitals of Rikillagaskada and Teldeniya. Both hospitals are situated in Central Province, which is the central hill country of Sri Lanka. These two hospitals drain patients from two banks of Victoria reservoir. Villagers in the area have occasionally witnessed that Asian giant honey bees are provoked by eagles attacking bee combs. Furthermore, they have experienced that the incidence of stinging by both insects is more common during the windy season, and this is compatible with the number of admissions we observed are higher during some months. Stinging by Asian giant honey bee and hornets is a common environmental hazard leading to many hospital admissions in Sri Lanka. However, hospital data are unreliable as the attending physicians very often fail to identify and name them correctly.[10] Among the victims, there are farmers, students, estate workers, travelers, etc. United States report 40 deaths due to insect stings and Australia, 2–3 deaths annually.[5] In Japan alone, 40 people are killed every year by stings from Asian Giant Hornets, but fatalities are mainly caused by allergic reactions, often from multiple stings.[13] During 2011–2012 above, two hospitals received 80 cases of sting: The majority of them were caused by Asian giant honey bee. All these patients were managed in the medical unit of respective hospitals by the medical team, who authorized this study.

Materials and Methods

Study Setting and Patient Recruitment

This study was carried out at the two base Hospitals in Teldeniya and Rikillagaskada, Sri Lanka, which is situated on either side of Victoria reservoir. All the patients presented to these hospitals following a wasp or big bee singing, during the period of 2011–2010 were included in the study. All the stinging incidents had happened in Victoria Randenigala and Rantembe Sanctuary is a forest reserve and is located in Central Sri Lanka. The area placed aside the western bank of the Mahaweli River, the largest river of Sri Lanka. Patients recruited in the study were given routine pertinent medical treatment during the ward stay.

Data Collection

Basic demographic and clinical details were recorded in an interviewer-administered standard datasheet, after obtaining informed written consent from the patients. Patients who did not consent were not included in the study. The authentication of the type of insect was done by authors.

Data Processing and Analysis

All the information obtained in individual data sheets were entered into a MS Excel spreadsheet. Data analysis was performed by means of measures of central tendencies using Minitab statistical software.

Ethics Statement

Ethical approval for the research work has been obtained from the local authorities. All the data were collected from the participants after obtaining written consent.

Results

There was a total of 80 patients in this study cohort, with 54 (32%) of them being victims of Horne stings and the rest being big bee stings (n = 26, 68%). The total group had an equal gender distribution (Male: n = 40, Female: n = 40) while big bee stings were common among females (n = 30, 56%), whereas hornet stings were more frequent among males (n = 16, 62%). The mean age of the total group was 45 years (SD = 16), and the majority of the patients were between the ages of 30 and 50 years in both groups [Figure 6].

All the stings had occurred between 6.00 am and 6.00 pm, and the occurrence between 9.00 am to 3.00 pm was more frequent, during which most of the people are engaged in estate works [Table 1]. The majority of the big bee stings (n = 26, 48%) had occurred while working in tea estates, whereas the hornet attacks were frequent around the dwellings (n = 12, 46%) [Table 1]. Almost all the stings had occurred accidentally while engaged in outdoor activities, and 50% of each group had no protective wearing at the time of stinging [Table 1].

Head and neck (n = 72, 90%), upper limbs (n = 48, 60%), chest (n = 28, 35%), and back of the chest (n = 24, 30%) were the commonly involved body regions in both groups of victims [Table 1]. Up to a maximum of 100 sting sites were noted among big bee victims, with the majority being <10, while the maximum number of hornets involved in a single case was five [Table 1]. All the patients were not aware of a history of allergy except one in the big bee group who did not have a history of allergies. On examination of patients, 95% (n = 53) of the big bee group had stings intact in their skin, and none of the patients attacked by hornet had stings in the skin. Pain (n = 78, 97%) and swelling around the stinging sites (n =69, 86%), redness (n = 50, 62%), and itching (n = 30, 37%) were the most common clinical manifestations seen in both groups [Table 2]. Vital parameters were generally normal in both groups [Table 3], and 86% of the total group, including the entire hornet group, had normal electrocardiogram (ECG) findings. Changes detected in ECGs of the big bee group were Sinus tachycardia (n = 7, 13%), T inversion in lead III (n = 2, 4%), T inversion in lead III, V1-V3 (n = 1, 2%), and occasional VE (n = 1, 2%).

All the patients were treated with intra venous (IV) hydrocortisone stat doses and 75 (94%) were given oral prednisolone over 2–5 days. In addition, 65 (81%) were given IV chlorpheniramine 2–6 days. None of the patients developed complications and the average duration of the hospital stay until complete recovery was 2 (SD = 1) days.

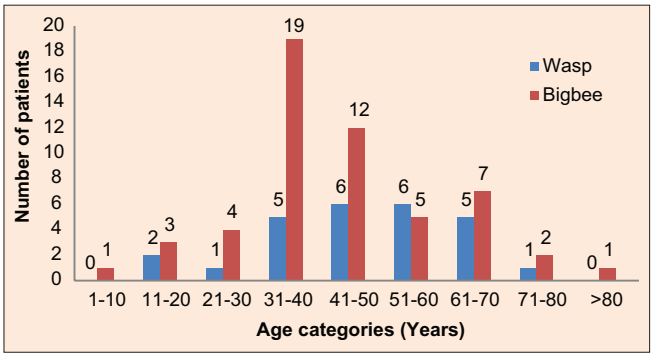

Figure 6: Age distribution of the victims of hornet and Big bee stings

Discussion

Venoms of the flying hymenoptera are largely aqueous solutions containing proteins, peptides, and vasoactive amines. The toxic properties of the venom are caused by these components collectively, and several of the venom proteins are allergenic. Immunologic cross-reactivity exists among the hymenoptera venoms and is extensive between yellow jackets and hornets, moderate between wasps and other Vespids, and minimal between honeybees and Vespids. Imported fire ant venom is distinctly different from the other venoms and consists of a mixture of piperidine alkaloids and a small aqueous component containing allergenic proteins. One of these proteins is similar to one of the Vespid allergens, and cross-reactivity between fire ants and Vespids occasionally occurs. Both systemic and large local

Table 1: General and epidemiological details of the victims with big bee and hornet stings

Body site	*Big bee; n (%)*	*Hornet; n (%)*	*Total; n (%)*
Site of bite			
Head and neck	51 (94)	21 (81)	72 (90)
Upper limb	35 (65)	13 (50)	48 (60)
Chest	22 (41)	6 (23)	28 (35)
Back of the chest	17 (31)	7 (27)	24 (30)
Lower limb	8 (15)	5 (19)	13 (16)
Abdomen	2 (4)	0	2 (3)
Number of insects involved			
1–10	28 (52)	26 (100)	54 (68)
11–20	9 (17)	0	9 (11)
21–30	7 (13)	0	7 (9)
>30	10 (18)	0	10 (13)
Place of exposure			
Estate	26 (48)	4 (15)	30 (38)
Home	10 (18)	12 (46)	22 (28)
Jungle	9 (17)	6 (23)	15 (19)
Road	9 (17)	4 (15)	13 (16)
Time of exposure			
6.00–9.00 am	6 (11)	6 (23)	12 (15)
9.00–12.00 noon	31 (57)	12 (46)	43 (54)
12.00–3.00 pm	16 (30)	5 (19)	21 (26)
3.00–6.00 pm	1 (2)	3 (12)	4 (5)
6.00 pm–6.00 am	0	0	0
Predisposition			
Accidental	54 (99)	26 (100)	80 (100)
Performing work or spending time outside	47 (87)	25 (96)	72 (90)
Lack of proper protection	27 (50)	13 (50)	40 (50)
Provocation by bird attack	6 (11)	0	6 (8)
Insect collection as a hobby	0	0	0

Table 2: Signs and symptoms

Signs and symptoms	*Big bee; n (%)*	*Hornet; n (%)*	*Total; n (%)*
Pain	53 (98)	25 (96)	78 (97)
Swelling around bite	45 (83)	24 (92)	69 (86)
Redness	37 (69)	13 (50)	50 (62)
Itching	26 (48)	4 (15)	30 (37)
Body swelling	23 (43)	23 (88)	26 (32)
Urticaria	16 (30)	2 (8)	18 (22)
Vertigo	11 (20)	7 (27)	18 (22)
Nausea and or Vomiting	7 (13)	4 (15)	11 (14)
SOB	4 (7)	4 (15)	8 (10)
Chest pain	3 (6)	1 (4)	4 (5)
Wheezing	2 (4)	1 (4)	3 (4)
Tinnitus	2 (4)	1 (4)	3 (4)
Abdominal pain	1 (2)	0	1 (1.25)

Table 3: Summary of the vital parameters

Parameter	*Big bee*		*Hornet*		*Total*	
	Mean (SD)	*Range*	*Mean (SD)*	*Range*	*Mean (SD)*	*Range*
Pulse rate/min	83 (10)	60–116	83 (7)	64–112	83 (12)	60–116
Respiratory rate/min	18 (2)	12–24	19 (2)	14–24	18 (3)	12–18
Diastolic blood pressure (mmHg)	76 (6)	60–100	83 (7)	60–110	78 (9)	60–110
Systolic blood pressure (mmHg)	120 (12)	90–180	130 (12)	100–160	123 (17)	90–180

reactions to stinging insects are usually caused by IgE-mediated reactions to hymenoptera venom. At least one prior sting is required to sensitize a person to venom, and sensitization is more likely to occur following multiple simultaneous stings or subsequent stings occurring over a relatively short period of time. Once sensitization has occurred, a sting can cause mast cell and basophil degranulation, resulting in the release of the histamine and other inflammatory mediators responsible for the signs and symptoms of anaphylactic and some large local reactions.[16,17] The venom of stinging wasps and bees contains compounds that cause intense pain along with swelling and redness. Consequently, stings around the head, eyes, necks, and inside the mouth and throat are especially serious. Since some yellow jackets are scavengers associated with unsanitary conditions, there is a possibility that a secondary infection may develop at the sting site. Of even greater importance, however, is the possibility of an allergic reaction to the venom from just one sting. Such reactions may range from swelling of part or all of the limb where the sting was received to the very serious, sometimes fatal, shock response involving several body systems. A severe (i.e., systemic) reaction can result in itching throughout the body, nausea, vomiting, wheezing, dizziness, confusion, slurred speech, drop in blood pressure, or unconsciousness and can possibly result in death. These complications in allergic individuals may happen very quickly, within 10–30 min of a sting, and most reported deaths occur within 1 h. Estimates of deaths in the United States due to insect stings range from 50 to 100 persons annually, but it is likely that many additional fatalities are not recorded, since the symptoms are very similar to those of heart attacks. There are reported cases of Kounis syndrome following hornet sting. Acute coronary syndrome after hymenoptera stings and other environmental exposures are referred to as the Kounis syndrome or allergic myocardial ischemia and infarction.[18,19] In some species, an alarm chemical (pheromone) is released on stinging or crushing of an insect that causes nestmates to join the attack. Wasp and hornet do not lose the sting after an attack and can sting repeatedly. Thus, multiple stings can be inflicted by wasp in a very short time.[4]

Our study shows a large number of victims (66.25%) belong to age 31–60 years who are working outdoor, carries a high risk of stinging. It may be associated with an individual's occupation. The majority of stinging is happened in between 9 am and 3.00 pm. Again it is related to their working time of the day. As most of the stinging was taken place without provocation, the time of stinging was unpredictable. One advice, we could give to these indwellers, visitors and workers are to wear protective garments as much as possible when they are involving the outdoor activities. In our study, no one has developed a severe complication. Almost all of them were given steroids and chlorpheniramine on admission. This treatment may have been prevented the severe complications. Hence, it is very important to supply enough stocks of these medications to all the hospitals. In the areas which have a high prevalence, public awareness programs such as signposts, education of the workers, travelers, and visitors will be effective in reducing the stinging hazards.

Conclusions

Hymenoptera stings have a significant social and health impact in the region of central hill country of Sri Lanka. Identifying the hymenoptera species correctly and improving awareness of life-threatening complications following stings among healthcare givers in the region and Islandwide is very important to prevent fatal outcomes. By improving public awareness and taking safety precautions can minimize the risk of stinging among the general public.

Acknowledgments

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Availability of Data and Material

The dataset generated or analyzed during the current study are available from the corresponding author on reasonable request.

References

1. Budagoda BD, Kodikara KA, Kilatatne WK, Mudiyanse RM, Edussuriya DH, Edirisinghe JP, *et al*. Giant Asian honeybee or Bambara stings causing myocardial infarction, bowel gangrene and fatal anaphylaxis in Sri Lanka: A case series. Asian Pac J Trop Med 2010;2010:586-8.
2. Robinson WS. Migrating giant honey bees (*Apis dorsata*) congregate annually at stopover site in Thailand. PLoS One 2012;7:e44976.
3. Basavarajappa S, Raghunandan KS, Hegde SN. Studies on the nest host trees of Asian giant honey bee, *Apis dorsata* F. in Southern Karnataka, India. Bioscan 2009;4:647-52.
4. Ciszowski K, Miekta-Ciszowska A. Hymenoptera stings. Przegl Lek 2007;64:282-9.
5. Fitzgerald KT, Flood AA. Hymenoptera stings. Clin Tech Small Anim Pract 2006;21:194-204.
6. Reed HC. Paper Wasps, Yellowjackets and Other Stinging Wasps. Oklahoma: Oklahoma Cooperative Extension Fact Sheet; 2016. p. 7305-7.
7. Hymenoptera Venom Allergy. Paschall VL; 2012. Available from: http://www.clevelandclinicmeded.com/medicalpubs/diseasemanagement/allergy/hymenoptera-venom-allergy. [Last accessed on 2016 Jun 07].
8. Available from: http://www.vespa-bicolor.net/main/social-bees/main.htm. [Last accessed on 2016 Mar 21].
9. A-Z Animals. Asian Giant Hornet. Available from: http://www.a-z-animals.com/animals/asian-giant-hornet. [Last accessed on 2016 Mar 28].
10. Asian Giant Hornet (*Vespa Mandarinia*). Available from: http://www.HornetJuice.htm. [Last accessed on 2016 Mar 28].
11. Kularatne K, Kannangare T, Jayasena A, Jayasekera A, Waduge R, Weerakoon K. Fatal acute pulmonary oedema and acute renal failure following multiple wasp/hornet (vespa affinis) stings in Sri Lanka: Two case reports. J Med Case Rep 2014;8:188.

12. Available from: http://www.lk.geoview.info/victoria_randenigala_and_rantambe_sanctuary,7474701. [Last accessed on 2016 Mar 28].
13. Available from: http://www.protectedplanet.net/victoria-randenigala-rantambe-sanctuary. [Last accessed on 2020 Feb 20].
14. Available from: http://www.asia-planet.net/srilanka/information.htm. [Last accessed on 2016 June 01].
15. Witharana EW, Wijesinghe SK, Pradeepa KS, Karunaratne WA, Jayasinghe S. Bee and wasp stings in Deniyaya; a series of 322 cases. Ceylon Med J 2015;60;5-9.
16. Xuan BH, Mai HL, Thi TX, Thi MT, Nguyen HN, Rabenou RA. Swarming hornet attacks: Shock and acute kidney injury-a large case series from Vietnam. Nephrol Dial Transplant 2010;25:1146-50.
17. Kularatne SA, Shahmy S, Rathnayake SS, Dawson AH. Clinico-epidemiology of arthropod stings and bites in primary hospitals of North Western province of Sri Lanka. Clin Toxicol 2018;56:1-6.
18. Ralapanawa DM, Kularatne SA. A case of Kounis syndrome after a hornet sting and literature review. BMC Res Notes 2014;7:867.
19. Ralapanawa DM, Kularatne SA. Kounis syndrome secondary to amoxicillin/clavulanic acid administration: A case report and review of literature. BMC Res Notes 2015;8:97.