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Oxyrachis tarandus Fab. (Homoptera: Membracidae) on rose apple (*Syzygium aqueum*)

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ABSTRACT: *Oxyrachis tarandus* Fab. (Homoptera: Membracidae), commonly known as cow horn bug or treehopper was found heavily infested on rose apple (*Syzygium aqueum* (Burm.f.) Alston, Myrtaceae). Infestation caused wilting, defoliation and structural abnormalities of fruits in *S. aqueum* and was found in 81 patches within a tree, which is further divided into peduncle, PD (48 patches), young terminal branches, YTB (20), older twig, OT (13), main bark, MB (0) and leaf, L (0). Infestation of shoot length ranged from 3 to 25 cm comprising a surface area of 5.47 to 25.47 cm^2. Population density of cow horn bug was significantly higher in PD compared to YTB and OT and peak infestation was noted during last week of March and first week of April. Prominent mutualism between *O. tarandus* and ant *Oecophylla smaragdina* was noted with strong positive correlation.

KEY WORDS: Cow horn bug, new host, population density, ants, mutualism

Oxyrachis tarandus Fab (Homoptera: Membracidae), commonly known as cow horn bug or treehopper, with two characteristic lateral and a median horn of the pronotum, is a phytophagous insect, where nymphs and adults feed on tender shoots. The regular dark brown-to-black adults measure approximately 7 mm in length. They hop about when disturbed and this habit has earned them the popular name "tree hoppers" (Ananthasubramanian, 1996; Ranga rao and Shanower, 1999; Nettimi and Iyer, 2015; Prabakaran *et al.,* 2017). They exhibit diversity in behavioral and life history traits including maternal care (subsociality), ant mutualism, host-plant specialization and plant-borne vibrational communication (Wood, 1993; Cocroft, 1996, 2001). It is considered as the minor pest as they do not appear regularly and thus a sporadic pest. It is considered as the minor pest as they do not appear regularly and thus a sporadic pest. However, it may be getting the status of major insect pest in near future due to intensive cropping, higher dosages of fertilizers and variation in microclimate (Ranga rao and Shanower, 1999; Garg, 2015; Rahmathulla *et al.,* 2015).

The oviposition site of *O. tarandus* is on young shoots, petioles or leaf midrib in a V-shaped slit. Eggs dispersed in clusters are being protected inside plant tissue covered by a white secretion and defended by female members. Presence of mutulistic ants also governs further protection. They utilize immature, often differentiating tissues of host plants and their phenology is synchronized with

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growth season of the host plant. Within few weeks after egg laying, hatching takes place. Aggregations of nymphs become largest on most vigorous plant modules thus, feeding gregariously on the sap of the shoot. Nymphs pass through five developmental stages to complete the life cycle within 2 to 2.5 months under optimum conditions. *O. tarandus* is distributed over the host plant in patches on young modules. Its abundance is low over a landscape, but may become numerous locally, which is meant for a stable population dynamics at the landscape scale and unpredictable locally. Formation of corky calluses, wilting and reduced plant vigor are the symptoms of heavy infestation. They undergo diapause in adult stage during environmental stress (Borror *et al.*, 1992; Ranga rao and Shanower, 1999; Price and Carr, 2000). The association observed between treehoppers and attendant ants (Hymenoptera: Formicidae) is one of the most familiar mutualisms between animal species, which is recognized as a common and important ecological interaction (Buckley, 1987; Stachowicz, 2001). Attendant ants are benefitted through a sugary waste excretion called honeydew produced by bug. Bugs in turn are benefitted through the protection governed by ants from its predators and parasites. Rose apple (*Syzygium* spp) is a common fruit plant in the home gardens and is grown commercially as the fruits are of high demand in the market for its delicious taste.

The present study was motivated by observation of huge number of *O. tarandus* and associated ants on rose apple, *S. aqueum* (Burm.f.) Alston (Myrtaceae), in Kannur district of Kerala, India. Current observations are significant, as rose apple (*Syzygium* spp.) has not been reported as the potential host plant for *O. tarandus* so far and its host association and ecology are discussed. Three different species of rose apple, *Syzygium jambos* (L.) Alston, *S. samarangense* (Blume) Merr. & L.M.Perry and *S. aqueum* were observed for the infestation of *O. tarandus* during the present study. A total of 30 trees (10 each from a species) were selected at random sites of Kannur district (11.9709° N, 75.6208° E) were examined during February to March 2020 and repeated during 2021. Observed trees were having a height of 5 to 8 m. Each tree was divided into regions of one meter each from bottom to top (A, B, C… etc.) to analyze the latitudinal distribution of cow bug over a single tree. Within each region infestation was examined under five sub areas namely, young terminal branches (YTB, recognized by green fleshy stem with a diameter less than 1 cm), older twig (OT, recognized by brown, scaly thick stem, with diameter more than 1 cm), main bark (MB, main strong axial stem, varied thickness from 25cm (base) to 5cm (terminal), peduncle (PD) and leaf (L). Measurements were taken to find the length of each infestation patches. Number of adults and nymphs in each patch was recorded (Nettimi and Iyer, 2015). Population density of each patch was calculated as number of insects per unit surface area. Statistical analyses were performed using standard statistical software, Graphpad Instat™ (GraphPad Software, Inc., La Jolla, CA; 1990-1993 Graphpad Software. V2 00, Uchitel, UC Irvine 921687S) and the data were expressed as Mean ± SD. Student's t-test (one tail) was performed to analyse any significant difference between two groups. Correlation regression analysis were performed to analyse the mutualism between *O. tarandus* and ants. Photographs were taken using Canon EOS 70D Digital SLR Camera with 18-135mm STM Lens and EF 75-300mm f/4-5.6 III Telephoto Zoom Lens.

Out of the three plant species observed, only *S.aqueum* was found infested with *O. tarandus.* A well established latitudinal variation and effective utilization of available resources are seen over the tree. Initially it was infested on region B (2nd from bottom) then spread over upper regions one by one on increase in population size as reproduction is going on. Lower most region A was left free throughout the observation period; it could be due to lack of young branches. Upper most region was also left non-infested (Fig. 1h) and authors suggests this as a behaviour most probably to avoid direct sunlight. Average surface area of prominent patches, PD, YTB and OT was 6.9 ± 3.1, 21.6 ± 4.0 and 112.7 ± 48.3 cm^2 respectively. A total of 81 patches of cow bug infestation were observed during heavy infestation (last week of March). Lower and higher temperature noted during the

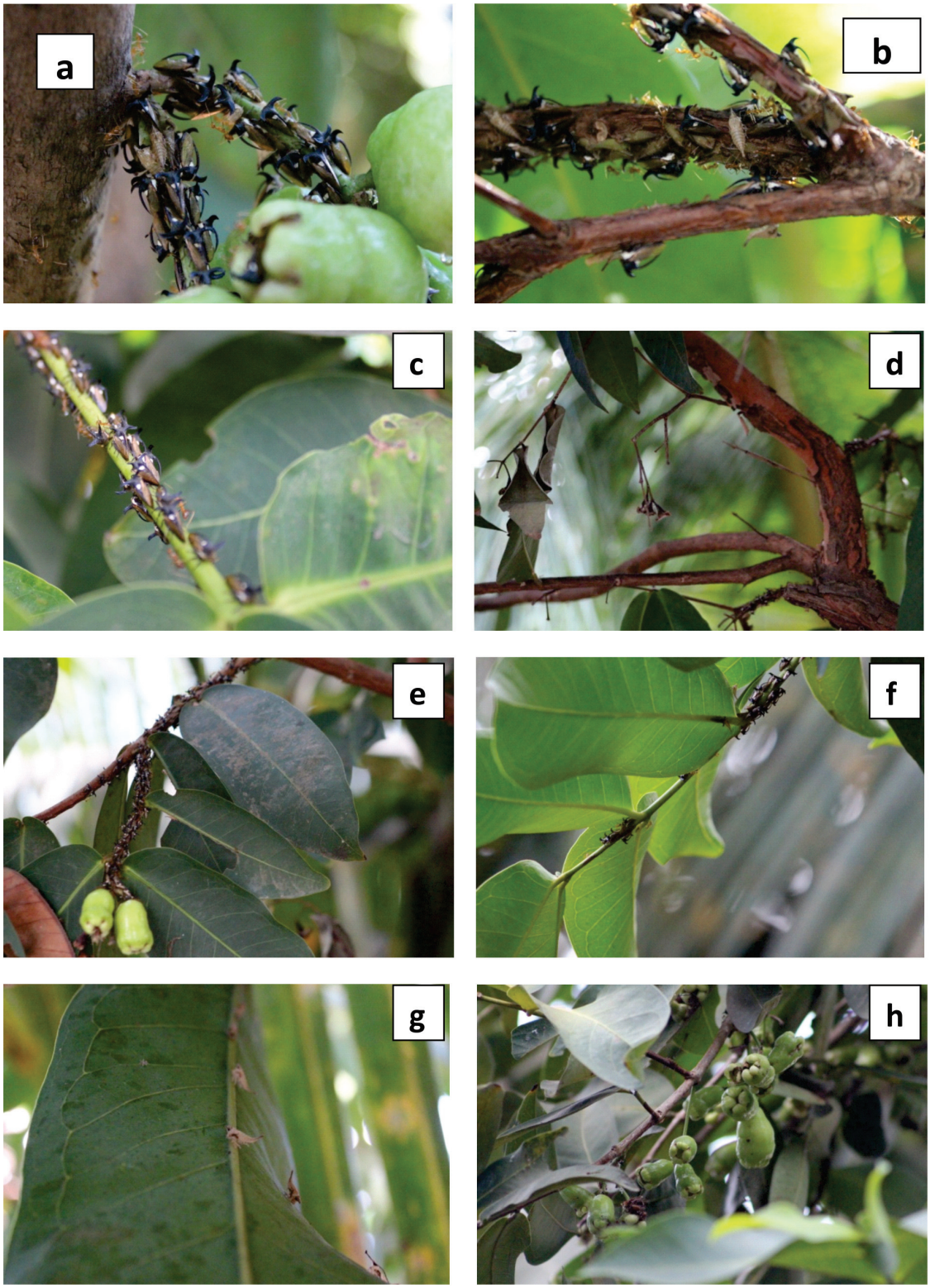

Fig. 1 Infestation of *Oxyrachis tarandus* on *Syzygium aqueum.* (a) Peduncle (PD), (b) Old Twig (OT), (c) Young Terminal Branch (YTB), (d) affected area showing wilting and scars, (e) Continuous patch of OT, YTB and PD, (f) Newly invading patch, (g) Exuvium on leaf and (h) Non-infested upper branches

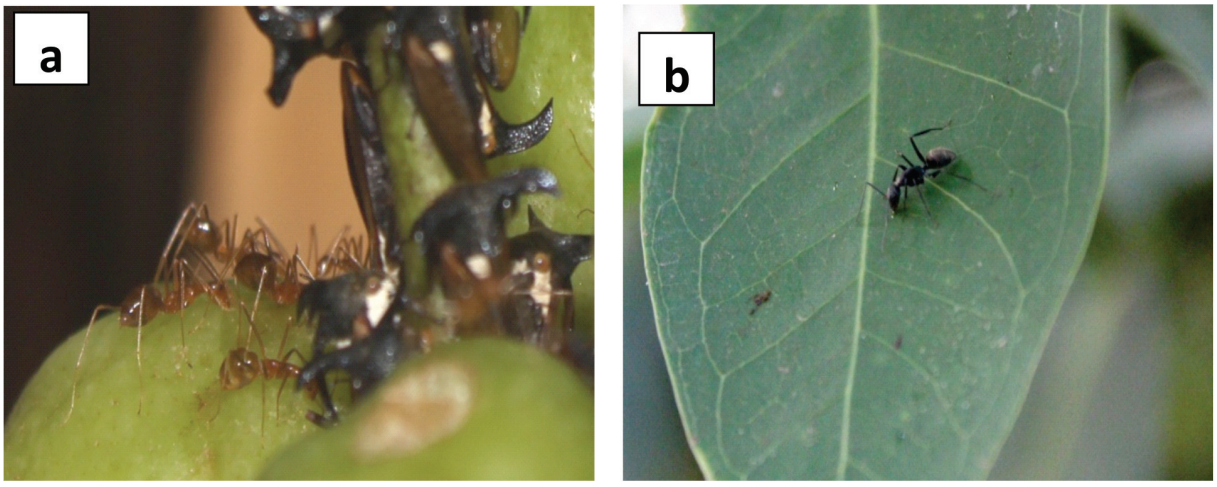

Fig. 2. Mutualistic ants *Oecophylla smaragdina* (a) attending cow bugs and *Camponotus compressus* (b) foraging to suck the honey dew from surfaces.

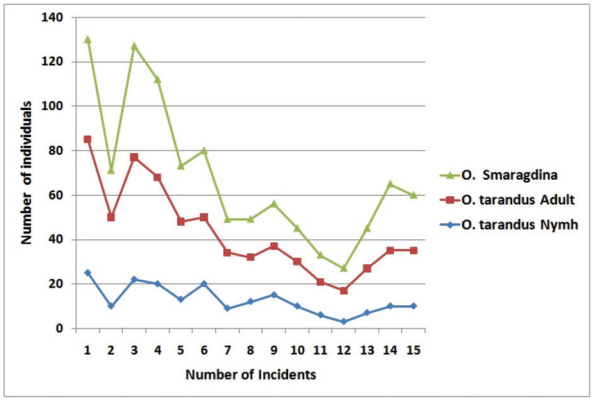

Fig. 3a. Graphs showing number of *Oxyrachis tarandus and Oecophylla smaragdina* observed in the infestation patches of *Syzygium aqueum*

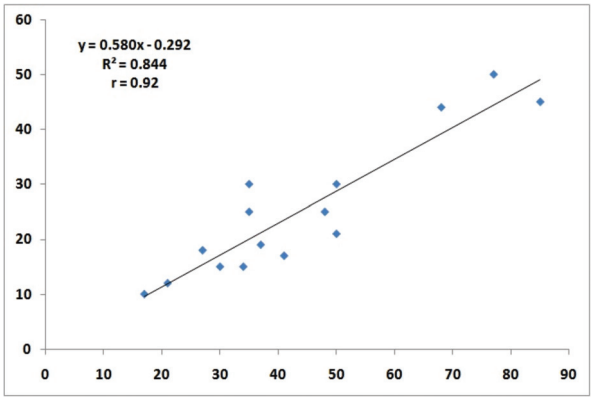

Fig. 3b. Correlation between number of *Oxyrachis tarandus and Oecophylla smaragdina* observed in the infestation patches of *Syzygium aqueum.*

peak period was 25°C and 35°C respectively. This is in line with the previous report on *O. tarandus* peak infestation on *Withania somnifera* (Ashwagandha) plant during March-April with average minimum and maximum temperature 16°C and 31°C respectively (Sharma and Patil, 2011) and on *Acacia nilotica* (Ali *et al*., 2008). Occurrence of *O. tarandus* shows a good positive correlation with environmental factors such as low temperature, high humidity and rainfall (Rahmathulla *et al*., 2015). Previous observations report peak infestation of *O. tarandus* also during November to January in pigeon pea (Claver, 2011) and June to July in mulberry (Rahmathulla *et al*., 2015). Variation in the peak of occurrence on different host across India at different months suggests host or climate specific change in the infestation period, but further studies are required to confirm it. Out of 81patches of infestation observed, 48 were PD patches (Fig. 1a), 20 YTB (Fig. 1c) and 13 OT (Fig. 1b). The cow bug used a much wider range of shoot length classes than other members of the membracidae (Price and Carr, 2000). No patches were observed on MB and L. On the lower side of the leaf, at random, about 3-5 exuvium were observed (Fig. 1g). On an average 19.8 ± 5.3 adult and 7.2 ± 2.9 nymph cow bugs were present over a PD patch of 7.0 ± 2.4 cm length. This account for a population

density of 1.52 individuals per cm^2 patch area which is significantly higher ($P < 0.05$) than all other patches observed. PD patches were retained about a week even after the fruit fall off from the peduncle, but with gradual decrease in the number of individuals over time. Distance between adjacent PD patches was not uniform as it depends on how frequently fruit stalk is present over a branch. Previous reports of patchy distribution of *O. tarandus* on host plants discussed mainly on the YTB patches and observation on peduncle patches (PD) is for the first time. There observed 23.4 ± 4.2 adults and 13.2 ± 4.4 nymphs over a YTB patch of 12.8 ± 1.9 cm length. This accounted for a population density of 0.66 individuals per cm^2 patch area which is significantly higher ($P < 0.05$) than OT lower than PD patches. Lowest density, 0.16 individuals per cm^2 patch, was recorded at OT where 47.6 ± 10.3 adults and 18.0 ± 6.3 nymphs were present over OT patch of 18.3 ± 5.3 cm length. Five situations, where OT, YTB and PD patches was continuous without any empty area in between comprising a length of 49.8 ± 4 cm were also observed (Fig. 1e). Even though patches without nymphs are seen, nymphs were always accompanied by adults (Fig. 1a-c). Offspring survival rates in treehoppers are improved through maternal care which represents an important behavioral and life history modification in them. Early treehopper instar's stylet is not strong enough to penetrate the epidermis of host plant tissues to suck the sap. At this situation adult females modify branches by making series of feeding slits to ensure the food resources accessible to nymphs (Wood, 1993).

Oecophylla smaragdina F. (Fig. 2a) and *Camponotus compressus* F. (Hymenoptera: Formicidae) show mutualism with cow horn bug for its honey dew (Way, 1963; Way and Khoo, 1992; Renault *et al.*, 2005; Nettimi and Iyer, 2015). There was a strong positive correlation between the number of *O. tarandus* and *O. smaragdina* in infestation patches with a correlation coefficient of 0.92 (Fig. 3a, b). Nettimi and Iyer (2015) reported strong positive correlation between *C. compressus* and *O. tarandus* on *Bauhinia tomentosa*. *Camponotus compressus* (Fig. 2b) are also observed but very rarely in patches with a frequency of 0.01 (1/100 observations) and therefore direct interaction of them with *O. tarandus* is too less. Outer to patches around 20 ants/ observation were found running so fast and stopping to suck the honey dew whenever they encounter it over the surface including leaf. Their lesser chance for direct interaction with *O. tarandus* forces them to utilize the minimum available honey dew, left by *O. smaragdina,* with minimum number of individuals. Abundance of *O. smaragdina* population check the number *C. compressus* in different host ranges as reported earlier by Ranga rao and Shanower (1999) and Sharma and Sundararaj (2011). Infestation of *O. tarandus* caused wilting and defoliation, but not at high rate. The size of fruit on infested and non infested peduncle shows significant difference, the infested fruit being shrinked and with pointed brown spot in large number. *O. tarandus* was recorded on mulberry plant, *Morus alba* (Sunil *et al*., 2003; Avhad and Hiware, 2013) and on sapling of *Dalbergia sissoo* (Sah and Ali, 2005). The review of literature reveals that this is first report of *O. tarandus* infestation on *S. aqueum* and as new host plant.

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