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SHORT COMMUNICATION



Diversity of mud-dauber wasps (Hymenoptera: Crabronidae: *Trypoxylon* Latreille) in a secondary forest of Trinidad, West Indies

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ABSTRACT

Over a two-year period we operated two intercept traps for flying insects near and within a well-developed secondary forest in the Arima Valley of Trinidad. These yielded 368 *Trypoxylon*, representing 30 species. The sample's Shannon–Wiener diversity of $H' = 2.61$ is higher than that from a comparable study of *Trypoxylon* on the smaller island of Tobago (15 species, $H' = 2.09$) and the even smaller Little Tobago (six species, $H' = 1.41$). Analysis of the samples by the Chao1 method suggests that the species numbers recorded on the two smaller islands are complete, while there is at least one additional species at the Trinidad locality. The four most abundant species in our samples show no evident bias in numbers of females between the wet and dry seasons, consistent with the hypothesis that at least these species nest throughout the year.

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Introduction

Trypoxylon is a worldwide genus of mainly solitary wasps with 630 known species (Pulawski 2016). They are slender wasps with a distinctive habitus (Bohart & Menke 1976, figures 104, 109, 110). Species tend to be physically distinct from each other, especially with respect to the sculpturing of the head. Sexual dimorphism is slight, so that there is little difficulty matching conspecific females and males. All studied species construct nests at least partly of mud, either free-standing or through modification of pre-existing cavities, and brood cells are provisioned with up to 20 paralyzed spiders (Bohart & Menke 1976; Iwata 1976).

Trinidad, Tobago and Little Tobago are continental islands off the northeastern coast of South America with a biota harmonic with that of the nearby mainland (Starr 2009). The islands have a moderately distinct dry season from about mid-January through mid-June. Starr and Hook (2003) reported 41 species of *Trypoxylon* from Trinidad (4768 km²) as a whole, while Hook and Starr (2006) recorded 15 species from intercept traps at a single locality (Goldsborough) on nearby Tobago (298 km²) and six on Little Tobago (1 km²). Our purpose here is to assess the spectrum of *Trypoxylon* species collected over two years from flight-intercept traps at one Trinidad locality and to compare their diversity with results from the two smaller islands. In addition, we analyzed possible seasonality in flight activity at the Trinidad locality.

Materials and methods

Our study site, the Asa Wright Nature Centre (10° 43.06'N 61° 17.90'W, readily distinguishable on GoogleEarth), is in the Arima Valley on the southern slope of Trinidad's Northern Range. The valley is 8.5 km long, characterized by steep hillside gradients, with the highest point at about 840 m (Beebe 1952). Our study site is an old cocoa estate intermixed with extensive seasonal evergreen forest.

Two Townes-model Malaise traps were set up, one in second-growth about 90 m from the nearest building and the other about 330 m further away in forest. We extracted and mounted all *Trypoxylon* collected from November 2013 through February 2016. We sorted specimens to morphospecies and assigned them to species groups according to Richards (1934). Where feasible, we identified species according to Richards (1934) and reference specimens identified by A.W. Hook. These latter, along with our material, are in the University of the West Indies Zoology Museum Land Arthropod Collection (UWIZM). Summary diagnoses of undetermined morphospecies are given in the appendix.

We calculated Shannon–Wiener diversity (H') and Pielou evenness (J') (Crowder et al. 2012) for our sample as well as for the specimens collected by Hook and Starr (2006) from Tobago and Little Tobago. We used the Chao1 method (Gotelli & Colwell 2010) to

estimate the number of species present but not yet collected (f_0) at each locality.

Results

Our traps yielded a total of 368 specimens of *Trypoxylon* (303 females, 65 males), representing 30 species (Table 1). These show a diversity of $H' = 2.61$, with Pielou evenness of $J' = 0.77$. In comparison, the 15 and six species from the Tobago and Little Tobago localities had respective H' values of 2.09 and 1.41. The three localities had almost identical evenness values (J') between 0.77 and 0.79, showing a very similar pattern of relative species abundance. Chao1 estimated f_0 values at or very near 0 for the samples from Little Tobago and Tobago localities. For the Trinidad locality, f_0 was 1.1.

For the four most abundant species in our sample almost identical numbers of females were collected in

Table 1. Spectrum and abundance of *Trypoxylon* specimens collected with two Malaise traps in the Arima Valley, Trinidad, West Indies over two years. Species groups are from Richards (1934). Specimens identified as '... of Hook' match those of the same designations in Starr and Hook (2003).

Species	Females	Males	Total
<i>superbum</i> group			
<i>T. olfersi</i> Richards	1	–	1
<i>nitidum</i> group			
<i>T. nr. agamemnon</i> Richards	4	–	4
<i>T. nr. scrobiferum</i> Richards	2	–	2
<i>punctulatum</i> group			
<i>T. pectorale</i> Richards	4	–	4
<i>albitarse</i> group			
<i>T. poss. fuscipenne</i> Richards	6	–	6
<i>fabricator</i> group			
<i>T. nr. asunsicola</i> Strand	5	4	9
<i>T. cornigerum</i> Cameron	3	–	3
<i>T. nr. crudele</i> Richards	4	1	5
<i>T. fabricator</i> Smith	2	–	2
<i>T. poss. grenadense</i> Richards	12	1	13
<i>T. leucarthurum</i> Richards	21	1	22
<i>T. maidli</i> Richards	37	4	41
<i>T. manni</i> Richards	4	–	4
<i>T. poss. moraballi</i> Richards	1	6	7
<i>T. poss. pachygaster</i> Richards	26	29	55
<i>T. rubrifemoratum</i> Richards	7	–	7
<i>T. nr. rugiceps</i> Dalla-Torre	1	1	2
<i>T. poss. trinidadense</i> Richards	12	–	12
<i>T. urichi</i> Richards	18	15	33
<i>T. fabricator</i> -group 1 of Hook	28	2	30
<i>T. sp. 1</i>	3	–	3
<i>T. sp. 2</i>	–	1	1
<i>fiebrigi</i> group			
<i>T. fiebrigi</i> Richards	5	–	5
<i>marginatum</i> group			
<i>T. nr. pentheri</i> Richards	1	–	1
<i>T. poss. punctivertex</i> Richards	4	–	4
<i>T. nr. sulcatoides</i> Richards	3	–	3
<i>T. marginatum</i> -group 1 of Hook	12	–	12
<i>T. marginatum</i> -group 4 of Hook	5	–	5
<i>rufidens</i> group			
<i>T. nr. capitale</i> Richards	70	–	70
<i>T. poss. rufidens</i> Cameron	2	–	2
Total	303	65	368

Table 2. Numbers of females of the four most abundant *Trypoxylon* species collected according to season from November 2013 to February 2016 in Malaise traps in the Arima Valley, Trinidad, West Indies. The dry season is estimated from mid-January to mid-June.

	Dry season	Wet season	Total
<i>T. nr. capitale</i> Richards	39	31	70
<i>T. maidli</i> Richards	15	22	37
<i>T. poss. pachygaster</i> Richards	10	16	26
<i>T. fabricator</i> -group 1 of Hook	17	11	28
Total	81	80	161

the (five-month) dry season and (seven-month) wet season (Table 2).

Discussion

These results are consistent with the hypothesis that diversity at single localities correlates positively with island size at this scale.

The near-0 Chao1 values suggest that traps at the Little Tobago and Tobago localities collected all species that were present. For the Trinidad locality, $f_0 = 1.1$, suggesting either one or two additional species yet to be collected. In fact, examination of buildings within 100 m of one of the traps showed many old nests of *T. albitarse* Fabr. and a few of *T. nitidum* F. Smith, neither of which is represented in our sample. The distinctive nests of these two species are common on human-made structures throughout Trinidad, but seldom found in any other situation (pers. obs.).

Although the spider prey is presumably more abundant during the wet season, our data seem to suggest greater female flight activity during the dry season (Table 2). We collected a mean of 16.2 females per estimated dry-season month, versus just 11.4 females per estimate wet-season month. This must be regarded as a very preliminary result, given that seasonality is not pronounced in Trinidad and fluctuates considerably from year to year.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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Appendix

Summary diagnoses of undetermined morphospecies of *Trypoxylon* wasps collected on Trinidad in the sequence in which they appear in Table 1. The sole representative of the *albitarse* species-group is omitted, as Richards's (1934) diagnosis of the group serves this purpose.

T. nr. agamemnon Richards. Lateral ocelli separated from eyes by less than half the ocellar diameter; frons densely micropunctate, with scattered medium punctures; body entirely black, except femora and trochanters dark brown, more than basal half of tergum 2 reddish.

T. nr. scrobiferum Richards. Vertex very narrow, lateral ocelli almost touching eyes; frons with median groove and sharp ridge on each side; terga 1–3 rusty-brown at apex and sides.

T. nr. asunicola Strand. A very small wasp with exceptionally elongate abdomen; lateral ocelli separated from eyes by almost one ocellar diameter; frons surface relatively smooth, densely medium punctate, with a very shallow, broad median groove descending to a high transverse ridge. Fore- and mid-femora brown above, hind-femur entirely brown.

T. nr. crudele Richards. Lateral ocelli separated from eyes by less than half the ocellar diameter; frons densely medium-punctate, with broad median furrow above, meeting a transverse ridge below, and with a distinct bulge to each side of the furrow; legs brown and yellow.

T. poss. grenadense Richards. Lateral ocelli separated from eyes almost by ocellar diameter; frons shiny, micropunctate, with indistinct, very shallow groove in its upper part and a very short median ridge just above the level of the antennal sockets.

T. poss. moraballi Richards. Ocelli large, lateral ocelli separated from eyes by less than half the ocellar diameter; frons very coarsely rugose, with broad median groove in its upper part that surrounds the anterior ocellus; metapleuron smooth, shining.

T. poss. pachygaster Richards. Lateral ocelli separated from eyes by more than half but less than the full ocellar diameter; frons densely medium-punctate, with very faint median groove ending in short transverse ridge below; legs largely pale.

T. nr. rugiceps Dalla-Torre. A very small wasp with exceptionally elongate abdomen; lateral ocelli separated from eyes by more than half the ocellar diameter but less than the full diameter; anterior ocellus surrounded by moderately deep depression; frons raised, rough, without median groove, with short Y-shaped ridge below.

T. poss. trinidadense Richards. Lateral ocelli separated from eyes by less than half the ocellar diameter; frons densely finely punctate, with shallow median groove ending in prominent, short, toothlike ridge below; mesopleuron smooth, shining, not striate except near border with propodeum; tergum 3 with basal orange-brown band.

T. fabricator-group 1 of Hook. Lateral ocelli separated from eyes by less than half the ocellar diameter; frons finely punctate, with median groove ending in short transverse ridge below; legs largely pale; terga 2–4 with pale basal bands.

T. sp. 1. Lateral ocelli separated from eyes by less than half the ocellar diameter; frons finely punctate, slightly swollen, with broad, very shallow median groove; sides of propodeum striate; mid- and hind legs largely pale.

T. sp. 2. Lateral ocelli separated from eyes by more than half but less than the full ocellar diameter; frons moderately raised, densely medium punctate, with short transverse ridge below.

T. nr. pentheri Richards. Very small, very elongate wasp; eyes conspicuously large; lateral ocelli separated from eyes by less than half the ocellar diameter; frons shiny, finely punctate, with distinct median groove extending to between the antennal sockets.

T. poss. punctivertex Richards. Lateral ocelli separated from eyes by less than half the ocellar diameter; anterior ocellus tilted anteriorly, surrounded by shallow depression; frons macro-punctate, main part in large raised inverted triangle, sharply set off at the sides and above.

T. nr. sulcatoides Richards. Lateral ocelli separated from eyes by about half the ocellar diameter; anterior ocellus surrounded by broad depression; frons densely coarsely punctate, with large raised inverted triangle, sharply set off at the sides and below by wave-like ridges.

T. marginatum-group 1 of Hook. Eyes swollen; lateral ocelli almost touching the eyes; frons densely finely punctate, with large, prominent V-shaped ridge; terga 3–4 with pale basal bands.

T. marginatum-group 4 of Hook. Small wasp, entirely dark except for contrastingly pale tarsi; lateral ocelli almost touching the eyes; anterior ocellus surrounded by deep depression; frons with large raised inverted triangle, sharply set off at the sides by relatively straight ridges.

T. nr. capitale Richards. Head distinctly swollen, eyes exceptionally large; lateral ocelli separated from eyes by less than half the ocellar diameter; frons densely punctate, with

faint median groove ending below in short transverse ridge; legs mostly contrastingly pale.

T. poss. rufidens Cameron. Head swollen, with exceptionally large eyes; ocelli very small; lateral ocelli separated from the eyes by more than half the ocellar diameter but less than the full diameter; frons swollen, dull, densely finely punctate, with very faint median groove ending below in prominent transverse ridge that is sharply set off from clypeus.