ON THE OCCURRENCE OF *BISTRISPINARIA*, GRASS-BREEDING FRUIT FLIES (DIPTERA, TEPHRITIDAE), IN KENYA, WITH AN ADDITION TO THE TEPHRITID CHECKLIST OF KAKAMEGA FOREST

Author(s): Robert S. Copeland
Source: Journal of East African Natural History, 96(1):95-102. 2007.
Published By: Nature Kenya/East African Natural History Society
DOI: http://dx.doi.org/10.2982/0012-8317(2007)96[95:OTOOBG]2.0.CO;2
URL: http://www.bioone.org/doi/full/10.2982/0012-8317%282007%2996%5B95%3AOTOOBG%5D2.0.CO%3B2

Journal of East African Natural History **96**(1)**:** 95–102 (2007)

ON THE OCCURRENCE OF *BISTRISPINARIA*, GRASS-BREEDING FRUIT FLIES (DIPTERA, TEPHRITIDAE), IN KENYA, WITH AN ADDITION TO THE TEPHRITID CHECKLIST OF KAKAMEGA FOREST

Robert S. Copeland
International Centre of Insect Physiology and Ecology
P. O. Box 30, Mbita 40305, Kenya
rcopeland@mbita.mimcom.net

ABSTRACT

Identification of specimens from Malaise trap collections and rearings of tephritids from native and cereal grasses confirm the presence in Kenya of *Bistrispinaria magniceps*, *B. fortis*, and *B. woodi*, of which the latter two species are recorded for the first time. Including an earlier, but uncertain, record of *B. atlas*, all four species of *Bistrispinaria*, the only genus of Tephritidae in the Afrotropical region known to breed in grass stems, have now been recorded from Kenya. Information is provided on the hosts of *B. fortis* and *B. magniceps*. Neither the spatial nor temporal distribution of *B. magniceps* in its primary host, *Panicum maximum*, was uniform. *Bistripinaria* species were collected in about 50% of Malaise trap samples from grassland and relict woodland habitats. Malaise traps were a cost effective and logistically simple way to survey for the presence of this uncommon genus.

An overlooked literature record of *B. magniceps* adds another species to the tephritid fauna of the Kakamega Forest, Kenya, reported previously, and brings the total to 136.

INTRODUCTION

The grass-breeding, and primarily Asian, subtribe Gastrozonina comprise an important group of the Tephritidae. The 26 known hosts of Asian gastrozonines are the young stems, or shoots, of bamboo species (Poaceae, Bambusoideae) (Hancock & Drew, 1999), and the relative richness of the Asian fauna, *i.e.* 89 species in 17 genera (Hancock & Drew, 1999; Wang, 1998 in Hancock & Drew, 1999) presumably reflects the great diversity of Asian bamboo species. Over 1000 species of bamboo are recognized from the Asia-Pacific region alone (Bystriakova *et al.*, 2003).

The African fauna, in contrast, is depauperate as is the African Bamboo flora. Currently, only a single genus (*Bistrispinaria* Speiser) composed of four species is unequivocally placed in the Gastrozonina (Hancock, 1999). Based on morphological similarities among *Bistrispinaria*, *Clinotaenia* Bezzi, and *Leucotaeniella* Bezzi, Hancock (1999) suggested that the latter two genera, also African, may belong in the Gastrozonina. However, to date, neither genus has been reared from grasses or found in Kenya.

The few rearing records of *Bistrispinaria* are all from the Poaceae (=Gramineae), but the host plants of *Bistrispinaria* species are poorly known (Hancock, 1999). This may be due, largely, to their near total absence from cereal crops, with a single record of *Bistrispinaria magniceps* (Bezzi) from *Zea mays* L., and a single record of *Bistrispinaria fortis* (Speiser) from *Sorghum bicolor* (L.) Moench (as *Sorghum vulgare* Pers.). Hancock (1999) also suggested that if *Bistrispinaria* species exhibit behaviour similar to their Asian bamboo-breeding relatives, they would primarily attack young plants which may be undersampled in surveys, reducing the likelihood of finding tephritids. Additionally, *Bistrispinaria* species superficially resemble species of the common African genus *Ceratitis* MacLeay, particularly those of the subgenera *Ceratalaspis* Hancock and *Pterandrus* Bezzi. In the past, *Bistrispinaria* specimens may have been mistakenly identified as *Ceratitis*.

During a recent survey of stem borer larvae from native and cereal grasses in Kenya, two *Bistrispinaria* species were reared from four species of native grasses. In addition, Malaise traps (Malaise, 1937) set in grassland and woodland in Ruma national park in western Kenya captured these two and an additional *Bistrispinaria* species. Here, I present the results of these collections.

MATERIAL AND METHODS

Host plant survey

Wild and cereal grasses were surveyed for stem borers between June 2002 and January 2004 in three Kenyan districts: Busia, Machakos, and Suba. Collections were made monthly, encompassing two short (*ca.* October–December) and one long (*ca.* March–June) rainy seasons and intervening dry periods. Collections were made on farms (cereal and surrounding native grasses) and in nearby undisturbed grassland. Twenty plants were sampled of each species present at the time of collection. Plants were recorded as belonging to one of three growth stages; vegetative, flowering, or fruiting. Plants assigned to the "vegetative" stage included all individuals that were yet to flower, and so encompassed plants at various stages of growth. For each native-grass plant, all tillers (emergent stems) were dissected in the field, up to a maximum of five tillers per plant. Fresh, cut stems of young maize plants were used as the rearing medium for larval borers found in dissected plants. Stems were spilt and a small trough was cut into one half. A single larva was placed in the trough, the two halves of the stem were realigned, and a rubber band was secured to hold them together. Each stem was placed in its own Petri dish and these were transported to the laboratory for rearing. Fresh maize stems were provided every two–three days.

In all, 44 458 individual plants representing 53 native grass species were destructively sampled and dissected for stem borers. Among cereal grasses, 4534 and 3677 maize and sorghum plants were dissected, respectively. For each district, the approximate latitude, longitude, and altitude of the collections, the number of native grass species and the number of plants sampled is given in table 1.

Malaise trap collections

Two Townes-style Malaise traps (Townes, 1972) were placed in Ruma National Park, western Kenya (table 1). Both traps were located in the same general area in which many of the "grassland" collections of Suba District had been made. One trap was set in grassland, at the junction of a small permanent stream and an isolated grove of *Acacia* trees. The grassland trap was set on 4 Dec 2005 and samples collected through 26 Mar 2006 were

Table 1. Grass and Malaise trap collection sites.

Collection method	District	Site	No. of native grass species sampled	No. of plants sampled	Latitude[1]	Longitude[1]	Altitude (m)[1]
Grass dissection	Busia	farms, grasslands	33	15 527	0°17'N–0°29'N	34°06'E–34°24'E	1162–1263
	Machakos		24	10 334	1°05'S–1°35'S	37°11'E–37°31'E	1224–1653
	Suba		29	18 587	0°24'S–0°43'S	34°09'E–34°21'E	1193–1370
Malaise trap	Suba	Ruma National Park, grassland			0°39.128'S	34°19.422'E	1240
		Ruma National Park, woodland			0°38.835'S	34°20.157'E	1264

[1]An approximate range of values is provided for the grass collections, which were made in many sites within each district.

examined. A second trap was placed in a relict woodland (sensu Greenway, 1973), comprising a mixture of indigenous and exotic trees. The woodland understory was dominated by native grasses. This trap was set on 11 Dec 2005 and collections were made through 1 Apr 2006. Traps were run continuously, except that damage to the woodland trap resulted in a four-week gap in sampling at that site. Insects were collected into 75% ethanol. Samples were collected after each two-week period, at which time fresh alcohol was added.

Voucher specimens

Representative voucher specimens of *Bistrispinaria* have been deposited in the Department of Invertebrate Zoology, National Museums of Kenya, Nairobi, in the National Collection of Insects, Tel Aviv University, Israel, and in the collection of the International Centre of Insect Physiology and Ecology, Nairobi.

RESULTS AND DISCUSSION

***Bistrispinaria* reared from grasses**

During the survey, stem borers were found in 38% (n=4534) of maize and 51% (n=3677) of cultivated sorghum plants, yielding 4693 and 3672 stem borers, respectively. However, no *Bistrispinaria* were found in the two cereal grasses. Among native grasses, stem borers were dissected from 15% (n=44 458) of plants representing 72% (n=53) of native grass species that were sampled. Sixty-one confirmed rearings of two *Bistrispinaria* species were made from native grasses collected in Busia District (table 2). *Bistrispinaria fortis* was reared on two occasions from *Pennisetum polystachion* (L.) Schult., the first record of *B. fortis* from Kenya. Previously, *B. fortis* was known from the Ivory Coast to Uganda, having been reared from *Sorghum bicolor* (L.) Moench (as *Sorghum vulgare* Pers.) in the latter country (Hancock, 1999). *Bistrispinaria magniceps* was reared from *Hyparrhenia cymbaria* (L.) Stapf, *Sporobolus pyramidalis* P.Beauv., and *Panicum maximum* Jacq.. The latter species was by far the most important host of *Bistrispinaria*. Fifty-seven of 61 (95%) adults (all *B. magniceps*) came from *P. maximum*, and *B. magniceps* used plants found both on-farm and in undisturbed grassland (table 3). Each of the other two rearings of *B. magniceps* was a single event and needs confirmation. Previously, *B. magniceps* had been reared from *P. maximum* in Uganda and Tanzania and from *Zea mays* L. in Tanzania (Hancock, 1999).

Table 2. Bistrispinaria *species reared from native grasses in Busia District, Kenya.*

Grass species	No. of plants sampled	No. of plants producing *Bistrispinaria* (%)	*Bistrispinaria* species	No. reared
Hyparrhenia cymbaria	1082	1 (0.09)	*B. magniceps*	1
Panicum maximum	1967	9 (0.46)	*B. magniceps*	57
Pennisetum polystachion	2063	2 (0.10)	*B. fortis*	2
Sporobolus pyramidalis	1399	1 (0.07)	*B. magniceps*	1

In Busia district, the spatial distribution of *B. magniceps* larvae was not uniform, both among *P. maximum* plants and among tillers within infested plants (table 3). Eighty-two percent of reared *B. magniceps* came from only 4 plants (0.2%, n=1967), 28% from a single tiller. Females may respond to plant cues that enable them to select stems that provide an optimal substrate for larval development. Since larvae were reared separately in the

Table 3. Bistrispinaria magniceps *reared from* Panicum maximum *in Busia District, Kenya.*

Date	Habitat	No. of *P. maximum* plants sampled	No. of plants infested by *Bistrispinaria* (%)	No. of tillers dissected on infested plant	No. of infested tillers	No. of *Bistrispinaria* per infested tiller
6-Nov-2002	Grassland	20	1 (5)	5	2	16
						4
6-Nov-2002	Grass surrounding sorghum	20	1 (5)	5	1	1
13-Nov-2002	Grass surrounding maize	20	2 (10)	5	1	1
				5	1	8
15-Nov-2002	Grass surrounding sorghum	20	1 (5)	1	1	1
4-Dec-2002	Grassland	20	1 (5)	1	1	3
7-Jan-2003	Grass surrounding maize	20	3 (15)	1	1	3
				4	1	9
				5	1	11

laboratory, we do not know if individual stems (tillers) can support the development to maturity of all larvae from the sometimes high populations seen in the field; up to 16 per tiller (table 3).

Temporal distribution was also non-uniform. Fruit flies were found only during the short rainy season of November 2002–January 2003. The reasons for this are obscure, since the principal host of *Bistrispinaria*, *P. maximum*, was sampled in Busia District during consecutive months from June 2002–January 2004.

Field staff in Machakos District reported rearing a single fruit fly from *Rottboellia cochinchinensis* (Lour.) Clayton (E. Kidiavai, pers. comm.), but this specimen was lost. Surprisingly (see below), no fruit flies were reared from grasses collected in Suba District. Overall, *Bistrispinaria* was reared from 9.4% (n=53) of native grass species, but made up only 0.5% (n=11 894) of the total number of stem borers dissected from native grasses.

Bistrispinaria from Malaise trap collections

Bistrispinaria magniceps was collected in the grassland Malaise trap during two sampling periods, while *Bistrispinaria woodi* (Bezzi) was recovered from traps in both grassland and woodland settings (table 4). A single specimen of a third *Bistrispinaria* species, probably *B. fortis*, was collected in the grassland trap. This specimen has the strong black bristles on the costa above both the end of vein Sc and the humeral vein, the latter of which distinguishes *B. fortis* from other *Bistrispinaria* species. However, the individual differed in the following ways from the description provided by Hancock (1999); (1) all femora completely black, except for the inner basal half of the fore femur, (2) wing band across vein dm-cu broadly connected to the band across vein r-m, (3) no white spots on posterior margins of tergites II, III, or IV. With only the single specimen to examine, however, it is prudent, for the present, to assume that it falls within the limits of variability among individuals of *B. fortis*.

Despite the low numbers of *Bistrispinaria*, specimens appeared in the traps at a relatively high frequency, being found in samples of 7 of the 14 two-week sampling periods. The Malaise trap collections represent the first record of *B. woodi* in Kenya. This species was reported previously from Nigeria, east to Rwanda/Burundi, and south to Malawi (Hancock, 1999).

Table 4. Collections of Bistrispinaria *species from Malaise traps.*

Trap location	Collection start date	Collection end date	*Bistrispinaria* species	No. of males	No. of females
Grassland	4-Dec-05	18-Dec-05	*B. magniceps*	0	1
Grassland	18-Dec-05	1-Jan-06	*B. woodi*	1	0
Grassland	1-Jan-06	15-Jan-06	*B. woodi*	1	0
Grassland	15-Jan-06	29-Jan-06	*B. woodi*	1	1
Grassland	29-Jan-06	12-Feb-06	*B. magniceps*	0	1
Grassland	12-Mar-06	26-Mar-06	*B. fortis*	0	1
Woodland	4-Feb-06	18-Feb-06	*B. woodi*	0	1

The genus *Bistrispinaria* in Kenya

All four members of the genus have now been reported from Kenya, though the record of

B. atlas might be an error. Previously, a male and a female from Kalinzu, Kenya were among the paratypes of *Bistripinaria atlas* (Munro) (Munro (1957) reported in Hancock (1999)). We have been able to locate the place name "Kalinzo", but not "Kalinzu", in Kenya (Kenya Government, 1970). Like Machakos District, Kalinzo is in Eastern Province, though farther east and at a lower elevation. However, all other collections of *B. atlas* are from western Uganda and Burundi (Hancock 1999), and it appears more likely that the "Kalinzu" cited by Munro refers to the Kalinzu Forest area of western Uganda. Attempts were made to locate the *B. atlas* paratypes in order to examine the specimen labels. However, searches in the collections of the Natural History Museum (London) and the National Museums of Kenya failed to locate these specimens.

Comments on collection methods

Bistrispinaria species were not reared from cereal grasses and, except for *P. maximum*, they were rarely encountered in native grasses. It is possible that the relatively low numbers of reared *Bistrispinaria* accurately reflect low population sizes in our study areas, or a preference for other, less common, grass species. However, considering that *Bistrispinaria* may normally attack young plants as do its Asian relatives (Hancock, 1999), most of the plants we sampled may have been too mature to yield these tephritids. In support of the latter explanation, no *Bistrispinaria* were reared from grasses sampled in and around Ruma National Park in Suba District, while three species were recovered from Malaise traps operated in the same area. The success we had in rearing adult flies from dissected grasses collected in Busia District may have been the result of sampling younger grasses there. Although this may be part of the explanation, the low numbers of flies we recovered from both grass dissections and Malaise trap collections, the fact that *Bisitrispinaria* specimens were reared only during a three month period out of 20 months of sampling, and the fact that specimens are not common in museum collections, suggest that population densities of *Bistrispinaria* species may normally be low. Unfortunately, no attempt was made to distinguish tephritid larvae from those of other dipteran stem-borers, and, therefore, neither larval mortality nor rearing success was estimated in this study.

The frequency with which *Bistrispinaria* appeared in Malaise trap collections, albeit in low numbers, suggests that, from a logistical point of view, passive flight-intercept traps are an efficient and cost-effective way to survey for the presence of these poorly collected fruit flies. Given the relatively sparse and widespread records of *Bistrispinaria* species, it is of interest that three of the four species were collected in the same area and in the same trap. *Bistrispinaria* may be more common than existing collection records suggest.

An addition to the Checklist of Tephritidae from Kakamega Forest, Kenya.

In our paper on the Tephritidae of Kakamega Forest, Kenya (Copeland *et al.,* 2005), we speculated that, although there were no records for *Bistrispinaria*, the extensive area of grasses in natural glades within the forest, and the many grasses associated with the farms around it, argued that *Bistrispinaria* was probably resident there. In fact, this had already been reported. Hancock (1999, p. 919) lists *Bistrispinaria magniceps* (Bezzi) from Kakamega Forest ("one ♂ ...., *c*. 5000', 18–19.vii.1974, D. Hollis ..."). This brings the total number of tephritid species from the forest to 136.

ACKNOWLEDGMENTS

The author thanks Dr. R. Bagine and the Kenya Wildlife Service for permission to place Malaise traps in Ruma National Park. P. Ollimo and E. Kidiavai were responsible for the rearing of stem borers in Busia and Machakos Districts, respectively. This research was funded partly by UNEP/GEF grant GFL / 2711- 01- 4345, Conservation of Gramineae and Associated Arthropods for Sustainable Agricultural Development in Africa, the Curtis W. Sabrosky Diptera Research Fund of the Smithsonian Institution, and CanaColl, Canada. For logistical support we thank Michael Gates, Systematic Entomology Lab, Plant Sciences Institute, Agricultural Research Service, USDA, Washington DC. Mike Sharkey of the University of Kentucky supplied Malaise traps purchased with funds from NSF grant EF-0337220.

REFERENCES

Bystriakova, N., V. Kapos, C. Stapleton & I. Lysenko (2003). Bamboo Biodiversity. UNEP-WCMC/INBAR.URL: http://www.unep-wcmc.org/resources/publications /UNEP_WCMC_bio_series/14.htm.

Copeland, R.S., W. Okeka, A. Freidberg, B. Merz, I. M. White, M. De Meyer & Q. Luke (2005). Fruit flies (Diptera, Tephritidae) of Kakamega Forest, Kenya. *Journal of East African Natural History* **94**: 247–278.

Greenway, P.J. (1973). A classification of the vegetation of East Africa. *Kirkia* **9**: 1–68.

Hancock, D.L. (1999). Grass-breeding fruit flies and their allies of Africa and Asia (Diptera: Tephritidae: Ceratitidinae). *Journal of Natural History* **33**: 911–948.

Hancock, D.L. & R.A.I. Drew (1999). Bamboo-shoot fruit flies of Asia (Diptera: Tephritidae: Ceratitidinae). *Journal of Natural History* **33**: 633–775.

Kenya Government (1970) *National Atlas of Kenya*. 3rd edition. Survey of Kenya, Nairobi. Pp 103.

Malaise, R. (1937). A new insect-trap. *Entomologisk Tidskrift* **58**:148–160.

Munro, H.K. (1957). Trypetidae. *Ruwenzori Expedition* 1934–35 **2**: 853–1054.

Townes, H. (1972). A light-weight Malaise trap. *Entomological News* **83**: 239–247.

Wang, X.-j. (1998). The fruit flies (Diptera: Tephritidae) of the East Asian region. *Acta Zootaxonomica Sinica* **21**, Supplement (1996), 1–338.