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Die-Back in Sonneratia Alba in Kenyan Mangroves is due to Attack by a Cerambycid Beetle and a Metabellid Moth

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ABSTRACT

Extensive die-back in the pioneer mangrove tree, *Sonneratia alba*, along the Kenyan Coast was investigated. It was caused by a cerambycid beetle *(Bottegia spinipennis)* and a metabellid moth *(Salagena obsolescens)*. The beetle attacked small branches, laying its eggs singly, while the moth attacked large branches, laying its eggs in batches. The beetle was found at two sites, Mida Creek in the north and Gazi in the south. The moth was only found at Gazi. Three parasitoids belonging to two species of *Echthromorpha* were reared from the beetle larvae. Some basic observations on the life histories of the two species are reported. Both species are Afrotropical in their distribution.

INTRODUCTION

The impetus for this research came from observations in 1992 of extensive damage to *Sonneratia* trees in Lamu and Gazi. There appeared to be considerable die-back of both mature and young trees. J. Kairo collected some of the affected branches and found them to be infested with insect larvae which he was able to rear through and which produced moths.

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The moth was initially identified as *Salagena discata*, a cossid or goat moth. These kinds of moths are frequent pests of ornamental and fruit trees, less commonly also of timber species. They are characterised by long life histories and high fecundities with single females able to lay over 1,000 eggs. Typically eggs are laid on the bark or inside emergence tunnels and the larvae bore into the pith of the stem.

The scale of the infestation, with in some cases almost every tree affected, attracted the attention of the various institutions concerned with Kenyan mangroves (FD, KWS, CDA, KEFRI and KEMRI). Concern was raised on two grounds: (i) that *Sonneratia alba* is a pioneer tree that buffers the effects of the open seas and assists other trees to establish themselves, stabilising the coastal profile; and (ii) that the infestation appeared to be increasing. A number of institutions were therefore invited to a workshop in Mombasa in September 1995 hosted by the KWS Netherlands Wetlands Programme together with CDA.

At this meeting the problem was discussed, institutional roles were assigned and proposals were invited. Some doubts were expressed as to how serious the problem was. Apart from an observation by Martin Johnson of the Lamu COMMIFOR Project that 70% of the Lamu *Sonneratia* had suffered crown die-back and 5% were dead, no quantitative data on infestation rates were available. Johnson also noted that: (i) *Sonneratia* was a relatively minor component of the mangrove accounting for only 3.5% of the trees; (ii) that its economic importance was very limited; and (iii) that attack seemed to be confined to levels above the peak spring tides, allowing survival and recovery. The question was raised as to whether or not the insect responsible was an exotic. If it was endemic to the region, then it was possible that the infestations were cyclical or were not threatening to the long-term survival of *Sonneratia*.

The major objectives of this study were to (i) verify the identity of the pest or pests, and (ii) to determine whether or not natural enemies in the form of insect parasitoids could be detected. This last point was critical because it would be a good indicator as to whether or not the pest was a recent invader of the Kenyan mangroves. The main reason why exotic pests are so damaging is that they escape their natural enemies from their place of origin and have no natural enemies in their new locality.

Study Sites and Methods

Field work was almost entirely at Mida Creek, although there were three trips to Gazi. (Map 1: p.256). At the beginning of the study at Mida, a quick survey was done of the distribution of the main stands of *Sonneratia* in the creek as a guide to future collecting efforts. Identifications were done by Dr. Maes and by M.L. Cox of the International Institute of Entomology (London). All material collected has been through sampling dead branches and dissecting them for the pests. Light trapping was carried out at Gazi over 4 nights (8-11 January, 1997). Immature insect specimens were either reared in split *Sonneratia* twigs or preserved in 70% alcohol and adults were killed with ethyl acetate, set and pinned. Some adults were retained alive for mating and oviposition and were kept in plastic containers or in insect net sleeves on live plants in growbags or in the field. Moth genitalia were dissected and mounted on slides and photographed at the National Museums of Kenya (NMK). All preserved insect material has been deposited in the NMK collections.

RESULTS

Taxonomy

Two different species of *Sonneratia* borers were collected, one a beetle and the other a moth. They are formally described in Appendix 19.1 and 19.2 (pp.288-289).

Field Collections

Eleven stands of *Sonneratia* at Mida were located ranging in size from 3-4 trees to more than 20 and were found mainly on the northern margins of the creek. A noticeable feature of the *Sonneratia* at Mida in comparison to that at Gazi was the relative absence of larger mature trees.

Table 19.1 *Summary of field collections at Mida and Gazi*

SPECIES	STAGE	MIDA	GAZI	TOTAL
Bottegia	Larvae	168	54	222
Bottegia	Pre-pupa	0	1	1
Bottegia	Pupae	12	0	12
Bottegia	Adults	11	1	12
Salagena	Larvae	0	152	152
Salagena	Pre-pupa	0	1	1
Salagena	Pupae	0	28	28
Salagena	Adults	0	0	0

Appendix 19.3 (p. 290) shows the collection dates, numbers and life history stages of the two species in the field samples from Mida and Gazi. These data are summarised for the two sites in Table 19.1. It appears that *Salagena obsolescens* is not present at Mida. The vast majority of specimens were larvae (91% for *Bottegia* and 84% for *Salagena*). Pupae were more common in the *Salagena* (15%) than in the *Bottegia* (4%) samples. No adults were observed in the field and the light trapping at Gazi failed to attract either of the two borers.

Life Histories

Because of the apparent absence of *Salagena* at Mida Creek, most life history observations were made on *Bottegia*. Neither species was reared all the way through its life cycle. In the case of the moth, the larvae died quickly in the split twigs in which rearing was attempted. One unmated adult female moth laid 1071 infertile, greyish brown eggs on the walls of a plastic container over 6 days (13-19 February) after eclosing on the 12th. Observations on the moth in the field at Gazi revealed a similar mode of attack to that reported by De Villiers & Mathee (1973), with the larvae tunnelling initially in the bark and subsequently into the hardwood, concentrating their attacks at the forks of branches. The attack sites are conspicuous in the field because of the large amount of frass and silk that collects on the bark at the tunnel openings. The damage is severe causing the death of large branches. As many as 25 late instar larvae were recovered from a single branch about 75 cm long.

The *Bottegia* larvae survived reasonably well in the split twigs although the adults which developed from them were small in comparison with those found in the twigs collected from the field, suggesting poorer nutrition. The longest period for which larvae were maintained in the twigs was 47 days. The length of the pupal stage was not monitored accurately but was about 2-3 weeks. The higher percentage of pupae in the field collections of *Salagena* (15% vs. 4%) suggests that the moth pupa lasts somewhat longer. Adult beetles were observed mating on four occasions, in each case 1-2 days after emergence. One mating was timed as lasting 5 minutes. Females laid eggs freely on the sides of plastic containers when so confined, laying between 4 and 30 eggs in one day. The greatest number of eggs laid by a single female was 51, laid on two successive days. Eggs were yellow in colour. When female beetles were confined on live *Sonneratia* seedlings in grow bags, they cemented the eggs singly on the fresh stems. Records of egg durations were inconsistent with some reported as hatching after 7 days and others after 31 days. The larvae disappeared on hatching and were presumed to have bored immediately into the stems. Leaf wilting followed rapidly, being observed in one case 4 days after the first egg had hatched. The larvae bore down into the stem towards its base. The orientation of 25 larvae in their twigs was recorded and in every case they had their heads pointing down the stems in which they were found.

The two species show a number of differences in their mode of attack of which the most obvious is that *Bottegia* attacked the small stems while *Salagena* went for the larger branches (Table 19.2).

Table 19.2
Differences in mode of attack between Salagena and Bottegia

FEATURE	*SALAGENA*	*BOTTEGIA*
Oviposition Behaviour	Eggs laid in masses at forks in large branches.	Eggs laid singly near stemtips.
Fecundity	Higher, capable of laying >1,000 eggs in 6 days.	Lower, maximum recorded number of eggs laid was 51 in 2 days.
Behaviour on Hatching	Feed gregariously on bark before boring in stem and tunnelling up into branch.	Bore directly into stems and tunnel downwards.
Size of Branches Attacked – Mean Diameter (s.d.)	Large; 140.5 (34.0) mm.	Small; 54.7 (13.0) mm.
Signs of Attack	Large branches die back; Conspicuous collection of frass and silk at branch forks.	Small stems die back; Little external signs of attack other than die-back.

Natural Enemies

Two Hymenopteran parasitoids were bred from beetle larvae during this study. They were identified by Koen Maes after comparison with named material from the collections of NMK as *Echthromorpha agrestoria variegata* Brulle and another unidentified *Echthromorpha* species. Parasitism rates were low with only 3 parasitoids recovered from a total collection of 273 *Bottegia* specimens at various stages.

Ants were also found in some of the stems that had been tunnelled by *Bottegia* larvae and they may also be occasional predators. No parasitoids were recorded from *Salagena* but sample sizes were much smaller.

Discussion

The major finding of this investigation is that more than one stem borer is currently attacking *Sonneratia* on the Kenyan coast and that the relative importance of the two species varies with location. At Mida the moth appears to be absent, while both species are found at Gazi. The strong preference of *Salagena* for the larger more mature *Sonneratia* trees may explain its apparent absence at Mida where such trees are rare.

It is clear that neither the moth nor the beetle are recent invaders from outside Africa. Each belongs to a genus with an Afrotropical distribution and all recorded localities for the two species are African. The presence of hymenopterous parasitoids attacking *Bottegia* is further evidence that this is an indigenous stem-borer. No parasitoids were recorded on *Salagena* but De Villiers & Mathee (1973) reared two unidentified species of parasitic Hymenoptera from the pupae. It is likely that larger samples of the moth would also reveal natural enemies at Gazi and elsewhere on the Kenyan coast.

However, it remains possible that one or both of the two species has made a recent host shift to *Sonneratia*, thus accounting for both the severity of the attacks and the lack of previous records. Such a host shift may enable an escape into enemy-free space if natural enemies of the stem borers on the old host orient specifically to the old host or its habitat. Nothing is known of alternative hosts of *Bottegia* (this report gives the first record for a hostplant for this genus), although one of its parasitoids (*E. agrestoria variegata*) has been recorded from caterpillars of *Katochalia junodi* Heylaerts (Lepidoptera, Psychidae) on coffee in Foumbot, Cameroon (Nonveiller 1984). Host plant records for *Salagena* species are more numerous and include various indigenous and fruit trees including cashew (De Villiers & Mathee 1973; Pinhey 1975; Latis 1990). Given the prevalence of cashew along the coast, a host shift from it to *Sonneratia* might not be difficult. The possibility of a host shift therefore seems to be higher for the moth than the beetle.

There is clearly an element of resource-partitioning in that the beetle attacks small stems while the moth attacks large branches. Such resource partitioning is sometimes the result of a long co-evolutionary history in which there is selection for individuals which avoid interspecific competition. This is however unlikely to be the case in the present instance.

The differences in attack characteristics between the two species are most probably due to fundamental differences in their life history biologies.

There is no available information in the literature on control of *Bottegia* but several measures have been used against *Salagena* on fruit trees. De Villiers & Mathee (1973) mainly used chemical control in litchi plantations. After 26 days of the treatment with 0.04% methidathion or 0.047% methomyl or 0.075% azinphos-methyl or 0.075% parathion, 95-100% of the larvae were dead. Latis (1990) also used chemical control in cashew plantations. The populations of the larvae were also reduced by manually removing the larvae and pruning affected branches.

Whether any control measures will be necessary to protect *Sonneratia* in Kenya's mangroves remains an open question that can only be settled by further monitoring at particular sites over a longer time period, by more extensive sampling at different sites, and by an analysis of costs and benefits. The relative importance of the moth and the beetle needs to be further investigated in different mangroves along the coast. Because of its greater fecundity and the size of the branches attacked, the moth is likely to be the more damaging of the two species, although not at all sites (e.g. not at Mida). Since *Sonneratia* has little commercial importance, any case for control measures would have to be made on the basis of its ecological importance as a pioneer species.

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Appendix 19.1

Bottegia spinipennis Fuchs 1961
(Coleoptera: Cerambycidae, Cerambycinae).
Fuchs, 1961, *Kol. Runds.*, 39, 28.
Type locality: Kidugallo, Tanzania.

Origin: Larvae, pupae and adults of this coleopteran were collected in fresh, dead and dying shoots of *Sonneratia* at Mida Creek (Malindi District) on the north coast of Kenya and at Gazi (Kwale District).

Systematics: Identification was done by M.L. Cox using the key in Quentin & Villiers (1971). *Bottegia* belongs to the tribe Psebiini. Quentin & Villiers recognise 12 genera in this tribe and four species of *Bottegia* Gestro, all found in Africa, namely *spectabilis* Gestro; *rusellae* Quentin & Villiers; *rubra* Aurivillius; and *spinipennis* Fuchs. There are no other species of *Bottegia* in the NMK collection.

Description: The elongate cylindrical larvae of this genus have not previously been described. Those of *B. spinipennis* closely resemble the larvae of *Pseudobottegia* sp. described by Duffy (1957) especially with respect to the elongate head and body, 2 pairs of black ocelli, segmented antennae with the basal segment usually long, the labium greatly extended and the legs 3-segmented. They differ in that the hypostoma is not smooth, but bears several longitudinal carinae and the body length in the last instar is 50 mm rather than 36. The pupae are exarate and are of the general form described by Duffy (1957). A description of the adult male and female is given in Quentin & Villiers (1971). According to these authors, the sexes may be distinguished by the colour of the tibia of the first two legs which are black in the female and reddish brown in the male.

Larvae and Hostplant: According to Duffy (1957), the larvae of *Pseudo-bottegia* are associated with *Syzygium* species (Myrtaceae) and attack the shoots which soon die off from the point of attack. The galleries are mostly in the hardwood. Prior to this study, no data were known as to the hostplants of *Bottegia* species. For more details of its mode of attack on *Sonneratia,* see below.

Distribution: Prior to this study this species was only known from Tanzania.

Appendix 19.2

Salagena obsolescens Hampson 1910
Lepidoptera: Metabellidae.
Hampson, 1910, *Ann. Mag. Nat. Hist.*, 8, 120, 164.
Type locality: Durban, South Africa.

Origin: Larvae and pupae of this moth were collected from dead and dying branches of *Sonneratia in* the mangrove forest at Gazi in Kwale District. Adults were eclosed from the pupae.

Systematics: Identification was done by Dr. Koen Maes. The following species of *Salagena* Walker occur in East and Southern Africa: *tessellate* Distant; *spiculata* Karsch; *albonotata* Butler; *narses* Fawcett; *atridiscata* Hampson; *irrorata* Le cerf; *albicilia* Hampson; *obsolescens* Hampson; and *discata* Gaede. The collections of NMK contain a further 5 to 6 undescribed species and some doubtful identifications.

Description: Thorax variegated pale and dark brown. Abdomen grey with prominent black or brown dorsal tufts near base followed by reddish-brown ones. Forewing cream with rows of black rings encircling reddish-brown spots; plain brown dots on the costa. Hindwing grey, sometimes pale white. Forewing 15-23 mm.

Larvae: Eggs are laid on the bark. A female was observed to lay 276 eggs (De Villiers & Mathee 1973). The larvae tunnel first in the bark and later in the wood, generally entering at a fork. Large quantities of frass and silk around the openings of the tunnels indicate the sites of attack. Pupation takes place in the tunnel. Though the larvae do not kill the trees, they cause die-back.

Hostplant: Reported as a borer in *Eugenia,* guava (Pinhey 1975), litchi, pecan, macadamia, avocado and several indigenous trees (De Villiers & Mathee 1973). Cashew was first mentioned by Latis (1990) for Zambia. It is here reported as a borer in *Sonneratia* in Kenya.

Distribution: Natal, Zululand, Transvaal and Mozambique to Zimbabwe, Zambia and equatorial East and West Africa.

Distribution in Kenya: South Coast, Mangroves of Gazi; Kitale (Stoneham Estate).

Appendix 19.3

Field collections of Sonneratia stemborers at Mida and Gazi

	DATE	SPECIES	STAGE	NUMBERS
Mida	23-25 Sep.'96	Bottegia	Larvae	49
	27-30 Dec.'96	Bottegia	Larvae	22
	2 Jan.'97	Bottegia	Larvae	28
	1-6 Mar.'97	Bottegia	Larvae	31
	1-6 Mar.'97	Bottegia	Pupae	10
	1-6 Mar.'97	Bottegia	Adults	4*
	20 Mar.'97	Bottegia	Larvae	13
	20 Mar.'97	Bottegia	Adults	3
	2 Apr.'97	Bottegia	Larvae	25
	2 Apr.'97	Bottegia	Pupae	2
	2 Apr.'97	Bottegia	Adults	4
Gazi	8-11 Jan.'97	Bottegia	Larvae	26
	8-11 Jan.'97	Salagena	Larvae	40
	8-11 Jan.'97	Salagena	Pupae	13
	5-7 Apr.'97	Salagena	Larvae	41
	5-7 Apr.'97	Salagena	Pre-pupa	1
	5-7 Apr.'97	Salagena	Pupae	15
	5-7 Apr.'97	Bottegia	Larvae	28
	5-7 Apr.'97	Bottegia	Pre-pupa	1
	5-7 Apr.'97	Bottegia	Adult	1
	19-22 Jun.'97	Salagena	Larvae	71

* 3 with parasitoid larvae